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S1-1 Age-related changes in olfactory mucosa and olfactory bulb.

Eric H Holbrook [1]

[1] Massachusetts Eye and Ear/Harvard Medical School, Boston, United States

The olfactory epithelium (OE) is capable of regeneration of depleted olfactory sensory neurons (OSNs) throughout our lifetime. The basal progenitor cells are responsible for providing this ongoing replacement and respond to injury through increased regenerative activity. However, the sense of smell in humans is known to decrease as a function of age despite this regenerative capability. We analyzed autopsy specimens of the OE and olfactory bulbs (OBs) with whole mount and tissue section staining from 36 human subjects. With age, there is a decrease in total olfactory neuronal area with increase in aneuronal and respiratory epithelial replacement that overall progresses in a posterior-dorsal direction. Mature OSNs decrease in density and there is a resulting decreased innervation of the OBs as a function of age. A trend toward decreasing globose basal cells (GBCs) in sections of OE with increasing age suggests a limited regenerative capacity of these stem cells over time. These findings are similar to those observed in a mouse model of OE aging where aneuronal and respiratory replacement occurs after a period of induced mature OSN death and resulting rapid GBC turnover. The OB in these mice also reveal decreased innervation with time, however glomerular structures return when the OE is allowed to recover. This would suggest the potential for functional recovery in humans with future epithelial based, basal cell interventions for smell loss.

S1-2 Odor identification alterations are associated with pathological changes at the olfactory mucosa of individuals with Alzheimer's disease

'Anne Maria Koivisto [1]

Riikka Lampinen [2], Laura Rantanen [2], Juho Kalapudas [3], Elina Penttilä [3], Katja Kanninen [2]

[1] Kuopio University Hospital, Kuopio, Finland
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[3] Kuopio University Hospital, Finland

Background:

Earlier detection of Alzheimer's disease (AD) is needed. Olfactory dysfunction (OD) often manifests before AD related cognitive problems and OD can act as a potential biomarker of early AD. Thus, olfaction and brain function is interesting target in AD research. We aim to examine this in alive individuals to develop new biomarkers for AD.

Method: We recruited 154 study participants (controls, individuals with mild cognitive impairment, MCI or AD). They underwent neurological examinations including cognitive tests, brain MRI, and test for olfaction (Sniffin' Sticks, 12 odors). Olfactory mucosa (OM) cells were obtained for the study via nasal biopsy from 36 study participants.

Results: We provide the background information for our study and report the demographic data of the study sample. Furthermore, individuals with MCI and AD displayed defects in identification of certain odors when compared to controls. We also demonstrated safe biopsy procedure of OM from the living individuals.

Conclusion: This OM cell biopsy technique and our study provide unique possibility to better understand pathophysiology of AD. Furthermore, we can combine clinical data to the cell findings to develop new biomarkers and find targets for treatments.

S1-3 Olfactory Mucosal Cells of Individuals with Alzheimer's Disease Display Alterations Similar to the Alzheimer Brain

Riikka Lampinen [1]

Simone Avesani [2], Alexey Afonin [1], Laura Mussalo [1], Veronika Górová [1], Muhammad Ali Shahbaz [1], Elina Penttilä [3], Heikki Löppönen [3], Rosalba Giugno [2], Anne M Koivisto [4], Katja M Kanninen [1]

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Impairments in olfaction are implicated in aging but also in several neurodegenerative diseases, including Alzheimer's disease (AD). Here, we describe cellular and molecular alterations in olfactory mucosa (OM) cells derived from individuals with AD or mild cognitive impairment (MCI) when compared to those derived from cognitively healthy control subjects.

OM biopsies harvested under local anesthetic were processed to primary cell cultures and subjected to transcriptomic, functional, and elemental content analysis. A pilot analysis of proteomic alterations in the OM was also carried out in a subset of samples. Single cell RNA sequencing unveiled the OM cultures to contain five distinct cell populations. When compared to controls, common transcriptional alterations for both AD and MCI OM cells were those related to mitochondrial function. A large fraction of the proteins found to be differentially abundant in AD and MCI OM biopsies were also mitochondrial. The AD OM cells also showed impaired mitochondrial function in functional assays. Elemental analyses by ICP-MS revealed increased levels of zinc, calcium and sodium in the AD OM cells in comparison to the OM cells derived from cognitively healthy subjects.

These results with unique OM biosamples of individuals with MCI and AD provide new information of the molecular alterations occurring at the OM and suggest mitochondrial impairment as a common pathological feature in the samples. The primary human OM cell cultures also provide a tool to study the impacts of exposure to airborne environmental stressors, such as air pollutants and viruses, and their potential link to neurodegenerative diseases.

S1-4 A multiomics approach to understanding the olfactory-brain connection in Alzheimer's disease

Laura Maria Rantanen [1]

Harley Robinson [1], Maina Bitar [1], Riikka Lampinen [2], Alexandre Cristino [3], Katja Kanninen [2], Anthony White [1]

[1] QIMR Berghofer Medical Research Institute, Brisbane, QLD Australia
[2] A.I. Virtanen Institute for Molecular Sciences, Kuopio, Finland
[3] Griffith Institute for Drug Discovery, Griffith University, Brisbane, QLD, Australia

Olfactory changes are one of the earliest pathological events in Alzheimer's disease, yet the relationship between nose and brain pathologies remains largely unknown. Here we have generated olfactory neurosphere cultures from Alzheimer's patients (AD), together with cultures from people with mild cognitive impairment (MCI) and matched healthy controls (HC). Neurosphere-derived cells have been subjected to unbiased transcriptomic, proteomic, and lipidomic analysis, which have revealed key differences between the cohorts. Transcriptomic (RNA-Seq) gene pathway analysis revealed disease-

related defects in multiple cellular processes associated with aging, intellectual deficiency, and actin cytoskeleton- and extracellular matrix organisation. A number of the leading differentially expressed genes have been associated with cognitive processes and also responses to environmental factors. Proteomic (mass-spectrometry) investigation of AD, MCI, and HC neurosphere-derived cells also identified changes consistent with altered extracellular matrix organisation, and cytoskeleton processes together with changes to mitochondrial/energy production that have been implicated in AD. Notably, we also identified significant AD-related changes in A-Kinase Anchoring Protein 6 (AKAP6) and 12 (AKAP12) by RNA-Seq, and proteomic analysis respectively. AKAPs regulate the spatial activity of many kinases, including protein kinases involved in AD pathology, and have key roles in healthy brain function. The lipidomic data is undergoing analysis, however, our combined multiomics analyses to date have demonstrated key insights into the potential links between olfactory changes and brain pathology in AD, together with the identification of putative olfactory biomarkers of early cognitive dysfunction. The studies highlight the value of olfactory studies to understand early AD pathogenic processes.

S1-5 The involvement of olfactory neural cells in neurodegenerative dementias

Gianluigi Zanusso [1]

[1] University of Verona, Verona, Italy

In Alzheimer's Disease (AD) or Dementia with Lewy Bodies (DLB), different studies have shown the presence of neurofibrillary tangles, β-amyloid deposits, or Lewy neurites in the olfactory sensory neurons (ONs). The olfactory neuroepithelium (OE) is a neural epithelium composed of various cell types, including olfactory sensory neurons, supporting glial-like cells, microvillar cells, and basal stem cells, and vulnerable to physical and chemical injuries. In humans, olfactory neurons undergo constant recycling every 2-3 months, but the half-life of the other glial-like neural cells is still undefined. To investigate the involvement of olfactory neuroepithelium in neurodegeneration, we set up a non-invasive and painless olfactory brushing procedure to collect olfactory neuroepithelium. This procedure detected trace amounts of aggregated pathologic prion protein in olfactory swab samples (OM) of patients with prion disorders using the Real-Time Quaking-Induced Conversion (RT-QuIC) assay. We expanded our study to α-synuclein dementias such as DLB, detecting α-synuclein aggregates in olfactory swabs of affected patients. By immunofluorescence, α-syn overexpression, and phosphor-α-syn deposits were observed in sustentacular and multivesicular cells of affected patients but not in controls. Finally, in patients with genetic FTLD-TDP, carrying TARDBP, PRGN, and C9orf72 mutations, TDP-43 aggregates were also detected by RT-QuIC for TDP-43 in olfactory swabs. In addition, phosphor-TDP-43 deposits were mainly found in the cytoplasm of Beta-III tubulin-positive cells (i.e., sustentacular and microvesicular cells) but more rarely in ONs. These studies indicate that we could detect the disease-associated forms of α-syn and TDP-43 in OM of patients with different forms of dementia.

S2-1 Trigeminal function and its association with olfactory perception

Thomas Hummel [1]

[1] TU Dresden Dresden Germany

Many odors activate the intranasal chemosensory trigeminal system where they produce cooling and other somatic sensations such as tingling, burning, or stinging. Specific trigeminal receptors are involved in the mediation of these sensations. Importantly, the trigeminal system also mediates sensitivity to airflow. The intranasal trigeminal and the olfactory system are closely connected. With regard to central nervous processing, it is most interesting that trigeminal stimuli can activate the piriform cortex, which is typically viewed as the primary olfactory cortex. This suggests that interactions between the two systems

may form at a relatively early stage of processing. For example, there is evidence showing that acquired olfactory loss leads to reduced trigeminal sensitivity, probably on account of the lack of interaction in the central nervous system. Decreased trigeminal sensitivity may also be responsible for changes in airflow perception, leading to the impression of congested nasal airways.

S2-2 Taste perception and its association with olfactory function

Carl Philpott [1]

[1] University of East Anglia, Norwich, United Kingdom

As part of the session on "Olfaction and other senses – combined disturbances, interaction and implications for evaluation and therapy", Prof. Philpott will discuss gustation, how this interlinks with olfaction in healthy individuals and the common misperceptions encountered with it as a separate sense, especially in cases of olfactory dysfunction.

S2-3 Hearing loss and olfactory function - associations and implications

Antje Welge-Lüssen [1]

[1] University Hospital Basel, Basel, Switzerland

Hearing loss - particularly in older people - is associated with cognitive decline, although the exact mechanism is still unclear and controversial. Loss of olfactory function in older people is associated with increased mortality. The impairment of two senses, a dual sensory impairment, is also associated with an increased risk of mortality, although there is much less data on this. Little is known so far about corresponding associations in younger people in middle age. In this presentation we will present associations between hearing loss, olfactory impairment and cognitive function in middle aged subjects and in particular discuss their clinical significance and implications.

S2-4 Frailty and olfactory function – is there any association?

Caroline Huart [1]

Victoria Van Regemorter [1]

[1] Cliniques universitaires Saint-Luc, Brussels, Belgium

In recent years, several studies have shown a strong link between olfactory decline and an increased risk of mortality in the elderly. The exact mechanisms underlying this relationship are still poorly understood. Frailty, that is defined as a biological syndrome of decreased reserve and resistance to stressors resulting in increased vulnerability, might be a possible factor driving this relationship. In this presentation, we will discuss the link between olfactory decline and frailty in the elderly, as well as potential clinical applications arising from it.

S2-5 Imaging techniques and the evaluation of olfaction

Katherine L Whitcroft [1]

[1] NHS, Sheffield, United Kingdom

Use of imaging in the clinical assessment of olfaction varies considerably between different geographical locations, and between different healthcare providers. In this talk I will outline the various basic and advanced techniques available, their relative clinical applications, and future possible uses. In light of current heterogeneity in practice, I will also outline the latest expert-agreed recommendations on imaging in the assessment of olfaction, as well as a roadmap for future research needed to increase the strength of evidence for these recommendations.

S2-6 How to manage ENT pathology in the olfactory cleft

Eri Mori [1]

Hirotaka Tanaka [1], Yuji Kishimoto [1], Monami Nagai [1], Rumi Sekine [1], Masayoshi Tei [1], Nobuyoshi Otori [1]

[1] The Jikei University School of Medicine, Tokyo, Japan

Rhinosinusitis and upper respiratory tract infections are well-known as causing olfactory disorders. However, "Olfactory cleft disease" which lesions are observed only in the olfactory cleft, is not widely recognized. Olfactory cleft disease causes olfactory disorder is diagnosed by sinus CT. It is often perceived as an olfactory disorder of unknown origin due to the absence of sinus shadows and the lack of abnormal findings on endoscopy. The following three causative diseases are identified:

Anatomical deformities (stenosis or closure due to concha bullosa or internal retroflexion of the middle and upper turbinate). Inflammation (mucus retention, mucosal edema, and adhesions in severe cases due to inflammation within the olfactory cleft associated with allergic rhinitis or upper respiratory tract infections). Tumors (including respiratory epithelial adenomatoid hamartoma).

Distinguishing inflammation from neurogenic olfactory disorders can be challenging and are often concurrent. The initial treatment involves the nasal rinses and corticosteroids. If the olfactory disorder persists, surgical treatment to correct the anatomic deformities of the olfactory cleft would be able to allow adequate airflow through the olfactory cleft and could improve olfaction. However, several pitfalls should be noted for this surgery. In this symposium, I would like to discuss diagnose and treatment strategies for olfactory cleft disease.

S3-1 Visualizing how SARS-CoV-2 attacks the olfactory system in COVID-19 patients

Peter Mombaerts [1], Laura Van Gerven

[1] Max Planck Research Unit for Neurogenetics, Frankfurt, Germany

[2] University Hospitals Leuven/KU Leuven, Leuven, Belgium

Anosmia, the loss of smell, is a common and often the sole symptom of COVID-19. The onset of the sequence of pathobiological events leading to olfactory dysfunction remains obscure. We reasoned that the neurotropic or neuroinvasive capacity of SARS-CoV-2, if it exists, should be most easily detectable in individuals who died in an acute phase of the infection. We have developed a protocol for rapid postmortem bedside sampling of these structures, using an endoscopic endonasal surgical technique that we adapted from skull base surgery. Our cohort included 115 COVID-19 patients who died a few days after infection with SARS-CoV-2, enabling us to catch the virus while it was still replicating. We found that sustentacular cells are the major target cell type in the olfactory mucosa. We failed to find evidence for infection of olfactory sensory neurons. We postulate that transient insufficient support from sustentacular cells triggers transient olfactory dysfunction in COVID-19 and that olfactory sensory neurons would become affected without getting infected. We failed to find evidence for viral invasion of the parenchyma of the olfactory bulb and the frontal lobe of the brain. Instead, we identified anatomical barriers at

vulnerable interfaces, such as by perineurial olfactory nerve fibroblasts enwrapping olfactory axon fascicles in the lamina propria of the olfactory mucosa. This poorly characterized cell type appears to seal olfactory axon fascicles hermetically from invasion by SARS-CoV-2 virions. We speculate that this barrier may also be effective against other pathogens that infect the nasal mucosa and could threaten the brain.

S3-2 Local immune cells and post-COVID hyposmia

Sarah Kim [1]

[1] Duke University, Durham, United States

Most individuals with COVID-induced olfactory loss recover olfactory function within days to a few weeks following acute SARS-CoV-2 infection, but as many as 12% of people continue to experience a significantly decreased sense of smell, or persistent hyposmia/anosmia, for months to years after COVID-19. The cellular basis of post-acute sequelae of SARS-CoV2 hyposmia in humans has been largely undefined. However, basic and translational research has begun to provide mechanistic insights into possible causes of chronic post-COVID olfactory disorder. We focus here on human subjects research, utilizing biopsy-based assays of the peripheral olfactory system in subjects with long-COVID hyposmia. Recent work involving histologic analysis and single cell sequencing of human olfactory mucosa biopsies outlines a potential pathobiological mechanism of long-Covid hyposmia: long after the resolution of acute infection, elevated numbers of specific local immune cells are evident. Pro-inflammatory mediators released by CD8+ T cells, and interactions involving other local immune populations such as macrophages, may impede survival and/or regeneration of new olfactory sensory neurons, and lead to a decreased ability to detect/process the presence of odorants. Ongoing studies to define the phenotypes and cytokine profiles of immune cells in post-COVID hyposmic human olfactory biopsies will help to better understand how a pro-inflammatory milieu may contribute to persistent post-viral hyposmia, and inform development of therapeutic strategies.

S3-3 Inflammatory Cytokines and the Olfactory Epithelium

Andrew Lane [1]

[1] Johns Hopkins School of Medicine, Baltimore, United States

The olfactory mucosa represents a potentially significant immune vulnerability to the host, subject to environmental and infectious insults in the nasal cavity while being in direct physical continuity with the intracranial space and brain through axon bundles that penetrate the skull base. Thus, in addition to its role as a sensory organ, the olfactory epithelium must act as an immune barrier, participating in mucosal defense and communicating with the local immune system via cytokine signaling. Inflammation is a normal component in the process of repair and regeneration following damage or infection. In ongoing inflammatory disease states, such as chronic rhinosinusitis, continuous production of cytokines by infiltrating immune cells can impact the structure and function of the olfactory epithelium. At the same time, expression of cytokines by resident olfactory cells can modulate the inflammatory cell populations and help direct the immune response. Bidirectional neuro-immune interactions provide another dimension in understanding olfactory epithelium physiology, particularly in relation to regeneration and sensory disturbance in the setting of nasal inflammation or infection.

S3-4 Current and future therapies for sensorineural and central olfactory dysfunction

Masayoshi Kobayashi [1]

[1] Mie University Graduate School of Medicine, Tsu, Japan

Although most COVID-19-induced olfactory dysfunction is a conductive olfactory dysfunction, some cases with long-lasting damage may be sensorineural or central olfactory dysfunction. Treatment strategies in such cases are based on promoting the regeneration of damaged olfactory cells and brain tissue. In the case of sensorineural olfactory dysfunction as postinfectious olfactory dysfunction (PIOD), tokishakuyakusan (mobilizing nerve growth factors to the olfactory bulb), zinc (promoting tissue metabolism) and vitamin B_{12} (repairing demyelinated nerve fibers) are efficacious. Olfactory training is also effective for PIOD and the combination of the oral medication and olfactory training has shown a higher rate of improvement in olfaction. The same is true for central olfactory dysfunction as post-traumatic olfactory dysfunction (PTOD) and the combination of the medication and olfactory training is highly efficacious in PTOD. If neural inflammation is acute, the administration of strong anti-inflammatory drugs shows significant efficacy. If potent anti-inflammatory interventions are administered within 7 days after injury, secondary injury due to a rapid rise in inflammatory cytokines released from primarily injured tissue is suppressed, resulting in better olfactory nervous system regeneration. After more than two weeks, however, the damage becomes more irreversible and functional impairment remains for a long time. The therapeutic strategy of transplantation of olfactory mucosa or stem cells has been investigated for such a chronic olfactory dysfunction. Recently, the possibility of olfactory implant for refractory anosmia has been investigated. In summary, there is a wide range of therapeutic strategies for the treatment of refractory sensorineural and central olfactory dysfunction.

S4-1 Smell and taste disorders: taking research and care further with patients' organizations

Claire Martin [2]

Claire Fanchini [1], Jean-Michel Maillard [1s], Chabha Djouder [1], Chrissi Kelly [3]

[1] Anosmie.org, France
[2] Anosmie.org, Paris, France
[3] Ckos, United Kingdom

Abstract from Anosmie.org's speech: Anosmie.org (France) aims to support people suffering from olfactory disorders and to raise public awareness of the consequences of olfactory dysfunction.

In collaboration with researchers, the organization has developed a simple, freely available olfactory training protocol. This protocol is based on scientific literature and its benefits have been validated by an observational data-based study. Our next objective is to develop an easy and quick screening tool for olfactory disorders at the earliest stages of life.

Moreover, Anosmie.org has established a partnership with Sanofi Genzyme, to shed light on nasal polyposis.

Abstract from Chrissy Kelly (AbScent (UK) and ckos): During the COVID-19 pandemic, patient forums became an accessible way for those affected to make contact with one another, share stories, and try to make sense of sudden sensory loss. The thousands of conversations that took place within the AbScent communities have contributed not just to understanding the progress of the condition, but also to the understanding of their needs.

Doctors treating patients with smell loss seek clinical solutions to their problems. Chemosensory scientists seek answers to research questions.

When patients discuss the help that they need, it becomes clear that some things fall outside the areas mentioned above. How can this disconnect be addressed? Looking at crowd sourced input from patients

in the AbScent community, which reached over 95,000 at the height of the pandemic, trends in patient experience and views on what it takes to achieve an increase in quality of life will be discussed.

S4-6 Lessons from the Covid-19 pandemic: meeting the needs of those with smell loss

Christine Kelly [1]

[1] AbScent/ckos London United Kingdom

The Covid-19 pandemic has brought much needed attention to smell disorders. During this critical period, patient forums became an accessible way for those affected to make contact with one another, share stories, and try to make sense of sudden sensory loss. The thousands of conversations that took place within the AbScent communities have contributed not just to understanding the progress of the condition, but also added to the understanding of the needs of this patient group.

Doctors treating patients with smell loss seek clinical solutions to the problems of their patients. This clinical application will be based on the evidence base and their experience–the tools they have to hand. Chemosensory scientists seek answers to research questions, and the course of this research will be dependent on the progress of that research over time, as well as outside determinants like funding and career progress.

When patients gather together to discuss their condition and the help that they need, it becomes clear that some things fall outside the areas mentioned above. How can this disconnect be addressed? Looking at crowd-sourced input from patients in the AbScent community, which reached over 95,000 at the height of the pandemic, trends in patient experience and views on what it takes to achieve an increase in quality of life will be discussed.

S5-1 Functional evolution of the taste and digestive system in birds

Maude W. Baldwin [1]

[1] Max Planck Institute for Biological Intelligence, Seewiesen, Germany

Sensory systems vary tremendously across organisms. As different species inhabit diverse environments and niches, sensory systems rapidly evolve to detect the cues relevant for a particular species. Examining these sensory changes in a comparative context yields insight into the evolution of the nervous system and animal behavior, and into broad questions about basic evolutionary processes such as the extent of convergence, the role of epistasis and contingency, and how novel protein functions arise. For instance, in some lineages of birds that rely on flower nectar or sap as food sources, the ability to sense sugars has convergently evolved through modifications of the ancestral savory receptor (T1R1-T1R3) – however, different parts of the receptor heterodimer have been recruited in different species. Moreover, identifying sensory shifts in the context of additional changes in an organism's physiology can yield insights into the relative timing of different traits, allowing us to reconstruct the series of events by which complex integrated phenotypes arise. Here, I will discuss our work examining the evolution of sensory and physiological diversity, focusing on the functional evolution of taste receptors and digestive enzymes in birds.

S5-2 Evolution of an olfactory subsystem in Hymenoptera: a potential springboard for eusociality

Jean-Christophe Sandoz [4]

Antoine Couto [1], Simon Marty [1], Patrizia D'Ettorre [2], Stephen Montgomery [3]

[1] CNRS, France
[2] Université Sorbonne, Paris-Nord, France
[3] University of Bristol, United Kingdom
[4] CNRS, Gif-sur-Yvette, France

The Hymenoptera present the highest number of eusocial species in insects and up to 9 independent origins of eusociality. By contrast, the eusocial lifestyle is virtually absent in other taxa, suggesting the existence of facilitating factors leading to advanced social organisation within Hymenoptera. As eusocial evolution is explained by the concept of inclusive fitness and the theory of kin selection, an ability to distinguish kin from non-kin could be instrumental for the advent of higher levels of sociality, by preventing costly altruistic acts towards unrelated individuals. Recent studies suggest that eusocial ants possess an olfactory subsystem that is specialised in the detection of cuticular hydrocarbons, providing a potential mechanism to detect social identity. It involves a particular type of sensilla on the antenna, the basiconic sensilla. They house olfactory sensory neurons (OSN) that are thought to express a group of odorant receptor genes with a distinctive 9-exon structure. These OSNs project to a segregated region of the primary olfactory centre in the brain, the antennal lobe. Strikingly, a similar suite of features has been observed in Vespid wasps which independently evolved a eusocial lifestyle, suggesting a potential link between this olfactory subsystem and advanced forms of social organization. By combining broad taxonomic sampling of Hymenoptera species with detailed neuroanatomical, functional and molecular characterisation of their olfactory structures, we aim to address the potential role of the basiconic-sensilla subsystem in social evolution.

S5-3 Neuromodulation of olfactory circuitry in Hemiptera

Gabriella Wolff [1]

Jessica Hearn [1]

[1] Case Western Reserve University, Cleveland, United States

Evolutionary changes in olfactory circuitry significantly impact animal host preferences, but how might neural plasticity affect host choice within a species or an individual? Some animals are feeding specialists and rely on one or a few hosts while others are generalists and may exploit a wider range of hosts. Neuromodulators like dopamine and serotonin can change the activity of cells and circuits and are necessary for behavioral plasticity including olfactory learning and host shifting. Might dopaminergic innervation to olfactory brain structures also affect generalist vs specialist feeding strategies? To answer this question, we assayed innervation of dopaminergic and serotonergic neurons to the antennal lobes of generalist and specialist species of hemipteran insects including aphids, whiteflies and leaf-footed bugs. This group represents the largest order of hemimetabolous insects and are unified by sucking mouthparts used to feed on plant or animal hosts. While serotonergic innervation patterns were more conserved across species, dopaminergic innervation patterns diverged across hemipteran antennal lobes. We discuss these divergences in the context of host choice behaviors in closely related species. Since Hemiptera includes many of the world’s most devastating agricultural pests and disease vectors, understanding the neurobiology of their feeding patterns is essential to their control.

S5-4 How aversive chemicals can become attractive to specialized herbivorous insects through evolution.

Teruyuki Matsunaga [1]

Noah K. Whiteman [2]

[1] The University of Tokyo. Chiba, Japan
[2] University of California Berkeley, Berkeley, United States

The diversity of herbivorous insects arises from their inclination to specialize in feeding on toxic plants. In an evolutionary twist, toxins betray the identity of their bearers when herbivores coopt them as cues for host-plant finding, but the evolutionary mechanisms behind this phenomenon remain poorly understood. We focused on *Scaptomyza flava*, a herbivorous drosophilid that specializes in feeding on isothiocyanate (ITC)-producing plants in the Brassicales. We identified paralogs Or42a and Or67b, which underwent multiplication as mustard-specific herbivory evolved. Using in vivo heterologous systems to express olfactory receptors, we discovered that *S. flava* Or42a and Or67b, unlike their homologs from microbe-feeding relatives, broadly responded to ITCs, with each paralog detecting distinct ITC subsets. In line with this, *S. flava* exhibited attraction to ITCs, mirroring the response observed in *Drosophila melanogaster* expressing *S. flava* Or67b3 in the homologous Or67b olfactory circuit. The cooption of ITCs as olfactory attractants in *S. flava* likely occurred through gene duplication and functional specialization (neofunctionalization and subfunctionalization), marking it as a recently derived herbivore.

S5-5 Evolution of neural circuits in Drosophilids

Lucia Prieto Godino [1]

Gong Hui [1], French Alice [1], Ruairi Roberts [1]

[1] The Francis Crick Institute, London, United Kingdom

Sensory systems encode the world around us to guide context-dependent appropriate behaviours that are often species-specific. This must involve evolutionary changes in the way that sensory systems extract environmental features and/or in the downstream sensory-motor transformations implemented. However, we still know little about how evolution shapes neural circuits. We address these fundamental questions using as models the olfactory systems of different fly species. We employ a multidisciplinary approach, including comparative connectomics, the development of genetic tools across species, fast volumetric calcium imaging, field work with environmental chemical analysis, and behaviour. I will present a project where the combination of these methods has uncovered the role of a local inhibitory interneuron population in the evolution of odour-guided behaviours. This work highlights the evolvability of central neural circuits and suggest that local inhibitory neurons might be hubs for change in the evolution of behavioural diversity.

S5-6 Are you my mother? How poison frog tadpoles distinguish caregivers from strangers.

Lauren O'Connell [1]

Julie M Butler [1]

[1] Stanford University, Stanford, United States

Establishing a strong social bond with our caregivers lays the foundation for offspring survival and fitness. As altricial offspring often cannot obtain their own food, energetically costly begging signals are displayed to their caregivers. Distinguishing caregivers from strangers ensures that these costly displays are directed towards individuals more likely to provide care. However, little is known about the neural basis of parental recognition and begging from the offspring perspective. We investigated how offspring recognize their parents using poison frog tadpoles that are altricial and rely on parental investment for healthy

development. In the mimic poison frog (*Ranitomeya imitator*), mothers provide food to tadpoles that beg (vibrate) more intensely. We first determined which sensory modalities tadpoles rely on for maternal recognition and found that tadpoles use olfactory cues for inter- and intra-species recognition. We then identified the brain regions and cell types involved in regulating begging behavior, which pointed to a prominent role for dopamine signaling. Our results show provide an example of how olfactory information gates communication and affiliation in the developing brain.

S6-1 Origin and evolution of vertebrate taste receptors

Sigrun I. Korsching [1]

Günes Birdal [1], Kanika Sharma [1], Vladimir Shiriagin [1], Adnan Syed [1], Maik Behrens [2]

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Chemosensation in vertebrates has segregated into an olfactory sense focused on discrimination and a taste sense focused on categorisation. Three of the five basic taste categories are detected by GPCRs, with sweet and umami tastants recognized by T1Rs and bitter tastants by T2Rs. Both taste receptor families have as their closest neighbors olfactory receptor families (V2Rs and V1Rs, respectively), which both were already present in the most recent common ancestor (MRCA) of vertebrates. We have revisited the origin of the taste receptor families and followed their evolution in vertebrates. In cartilaginous fish we find a single T2R as sister clade to all bony fish T2Rs, which is expressed in taste tissue and may be as close to the ancestral function as possible for extant receptors. T2Rs of bony vertebrates evolve rapidly in the lobe-finned lineage including lobe-finned fish, but not so much in the ray-finned lineage. In particular in teleost fish, T2R gene duplications are relatively rare, with few exceptions, paralleling the evolutionary characteristics of the sister family of V1Rs in teleosts. The T1R family of cartilaginous fish already possesses several members intermingling with bony fish T1Rs suggesting some T1R genes to be older than the MRCA of cartilaginous and bony fish. Nevertheless, T1Rs (and T2Rs) are absent from jawless fish genomes. These evolutionary studies can serve to select instructive species and gene comparisons for functional analysis, thus enabling us to better understand the evolution of function of taste receptors.

S6-2 A matter of ancient taste: Conservation of T2R function in fish and other species

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Vertebrates rely on their bitter taste perception to detect potentially harmful compounds in food prior to ingestion. In order to detect the large variety of chemically diverse bitter substances, vertebrates are equipped with a variable number of bitter taste receptors expressed in their gustatory system and beyond. Comparative analyses of bitter taste receptors in numerous species suggested a highly dynamic evolution as evident from frequent gene births and deaths, species-specific gene expansions, and grossly differing sizes of bitter taste receptor gene repertoires. It was believed that the dynamic evolution of bitter taste receptors enabled species to conquer different habitats and to establish individual feeding patterns, a fact that was underscored by comparative functional experiments demonstrating e.g. highly diverse agonist spectra of orthologous human and mouse bitter taste receptors. However, recent functional profiling experiments revealed a surprisingly high degree of functional conservation despite vast evolutionary distances. The presentation will provide examples from recent studies in which we observed surprising

levels of conservation of vampire bat and human orthologous T2Rs towards bitter salts, bony fish and shark T2Rs with almost identical agonist profiles as well as highly conserved cross-reactivities to different substance classes. Special emphasis will be given to presumably “ancient” bitter compounds. Taken together, these observations suggest that not only food-related bitter substances shape the evolution of bitter taste receptors, but also putative endogenous agonists contribute to this process.

S6-3 Bitter taste receptors in the domestic dog (Canis familiaris)

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Understanding differences in how domestic dogs and their owners perceive the world can only strengthen the unique bond shared between these two species. Here we present research on the sense of bitter taste in dogs. Dogs have a well-developed sense of bitter taste, with both similarities and differences to that of humans. Chromosomal arrangement of the 16 dog *Tas2rs* largely mirrors that of humans, with two main clusters of *Tas2r* genes on chromosomes 16 and 27 containing genes orthologous to those on human chromosomes 7 and 12 respectively. Expression in taste papillae is also similar, with the majority in the circumvallate papillae and some in the fungiform papillae, particularly towards the posterior of the tongue. The incidence of genetic variants is also similar, although the location of the variants differs. For example, the human TAS2R38 taster (PAV) and non-taster (AVI) haplotypes are not conserved in dog Tas2r38 (PVI). Ligand binding profiles of orthologous receptors also differ in many cases. In one specific example differences in Tas2r10 result in a lower sensitivity to denatonium benzoate *in vitro*. This is at least partly related to sequence differences in the second extracellular loop region, which acts as gatekeeper to the orthosteric binding site in some 7TM receptor families. In agreement with these data, dogs show a higher taste threshold for denatonium *in vivo*, which may present opportunities for further research on important interspecies differences in taste perception, given the use of denatonium as a bitter tasting deterrent in some toxic household products.

S6-4 T2R repertoire and adaptation to ecosystems in pigs (Sus scrofa)

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The high inter-species variation in the bitter taste receptor repertoire (T2R) is unparalleled when compared to other taste and nutrient sensor families (i.e., carbohydrates, amino acids, and fatty acids) which are often highly conserved across mammalian species. For example, the homology between the porcine and human taste receptor repertoires is high for non-bitter taste genes but low for T2Rs. This is also true within the *Sus scrofa* species when comparing different breeds. Whole genome sequences of 77 pigs from across the globe were studied looking for taste-relevant gene polymorphisms. The pigs selected included commercial lines and several local breeds (up to 14 total). The genomic analysis showed that the porcine gene sequences encoding receptors for carbohydrates, amino acids or fatty acids were highly conserved across breeds whilst the T2R family showed high divergence. It was suggested that bitter taste is a plastic trait that allowed pigs to adapt to diverse ecosystems thus facilitating the migration of the specie. Our group has recently reviewed the porcine T2R repertoire which had been previously reported as 11 protein coding gene and 4 pseudo genes. After performing a transcriptomic and validation PCR analysis of the porcine circumvallate papillae, two novel transcripts

(ENSSSCT00000089410.2 and ENSSSCT00000091318.1) were proposed to be novel porcine T2R family members: A0A5G2RA33 and T2R-new. Overall, the T2R repertoire of the pig consists of at least 13 functional genes with a high presence of polymorphisms across the population which may have contributed to the adaptation capacity of the *Sus scrofa*.

S7-1 Smell and taste loss as chronic disease biomarkers

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The COVID-19 pandemic has brought smell and taste dysfunction to mainstream attention. Yet, the diagnosis of chemosensory disorders is far from being accessible to most patients or routinely employed by most healthcare providers. Chemosensory loss is associated with marked reduction in quality of life, poor mental, nutritional and brain health, and with increased 5- and 10-year mortality in older adults. The availability of routine administration of direct smell screening as part of normal health care would significantly improve health care experiences, health outcomes, and quality of life for current and prospective patients, as well as reduce the economic burden of chemosensory dysfunction and its consequences. In this talk, I will explore how to advance the use of chemosensory testing in multiple contexts to speed diagnosis of chemosensory disorders and associated health problems, facilitate therapeutic and supportive interventions for affected individuals, and promote an improvement in human health and quality of life.

S7-2 Do taste and smell deficits impact food liking in neurodegenerative cohorts?

Catherine Anna-Marie Graham [1]

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Taste and smell deficits can lead to malnutrition and a decreased quality of life, particularly in neurodegenerative diseases (ND) such as Parkinson's Disease (PD) and stroke. While the correlation between these deficits and PD is well-established, the relationship in other ND remains less defined.

This research project seeks to comprehensively assess taste and smell deficits in patients with ND, by identifying specific deficits and examining their potential influence on food liking. By cross-sectional analysis, we examined 83 patients with PD (n=20), stroke (n=33), and other ND (n=30), comparing them with sex-and age-matched healthy controls (HC; 62±16 years, 37% female).

Our findings indicate that patients with ND consistently underperformed HC in smell identification ($p<0.001$). The disparities were evident across sub-cohorts. All individual scents were identified less frequently in patients with ND, when compared to HC ($p<0.05$), except orange, cinnamon and clove. Furthermore, patients with ND exhibited reduced taste perception compared to HC ($p<0.001$). Specifically, deficits were noted in identifying sour and salty tastes. Lastly, regression models demonstrated that ND is a significant risk factor for a lower liking for food groups such as fish, meat, fruit, and sweet foods ($p<0.05$).

These results emphasise the widespread impact of ND on taste and smell perception, highlighting potential areas for intervention to improve the nutritional well-being and overall quality of life for affected

individuals. As data collection progresses, a more comprehensive understanding of these deficits and their implications on food liking will be elucidated, offering valuable insights for future clinical management.

S7-3 The impact of genes on senses and food preferences in the aging

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Genetics plays a crucial role in sensory perception and food preferences. Despite the moderate/high heritability, little is known about the genes involved. Understanding the impact of genes on sensory perception and food preferences could be of great importance in developing personalized nutrition recommendations, especially for elderly people, for whom reduced sensory ability (RSA) may lead to health problems due to an inadequate dietary intake.

Our study included 1155 Italian individuals, for which data on sensory perception (smell, hearing, taste), food preferences, eating behavior, lifestyle, health parameters, and genetic information are available. Regression models and Genome-Wide Association Studies (GWAS) were performed to investigate the relationships between variables.

Around 70% of the subjects showed RSA in at least one sense, with taste being the most prevalent (55.2%). Male sex, aging, and low educational level were risk factors for RSA. RSA was also a predictor of diminished food adventurousness and lower liking for different foods. GWAS highlighted several genes associated with RSA and food liking (p-value<$1x10^{-6}$). In particular: *BCL7C*, part of the HMG-CoA reductase inhibitors pathway involved in the aging process; *MACROD2*, primarily expressed in the brain and associated with cognitive performance and brain connectivity measures; *RGS9*, associated with sweet food liking, and also food adventurousness, reward dependence, health status (BMI, blood glucose).

These findings represent an important starting point for understanding the molecular processes involved in sensory perception, food preference and eating behavior. They could be used to develop targeted interventions, define specific recommendations, and represent a first step toward personalized nutrition.

S7-4 Taste phenotypes, endogenous factors and their role in health and disease

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Poor food choices and excessive consumption significantly contribute to the rise of modern chronic diseases, particularly impacting the prevalence of obesity and related health issues. Therefore, understanding the determinants of food preferences and choices is crucial for crafting effective public health interventions aimed at fostering healthier eating habits.

Research indicates substantial differences among individuals in their responses to taste and sensory stimuli, which can serve as reliable indicators of dietary quality and overall health. This presentation delves into the intricate realm of taste complexity, examining variations in sensory-liking patterns for basic tastes, known as taste phenotypes, and their associations with dietary habits and body composition.

Furthermore, given that human eating behaviors are influenced by a multitude of factors, including sensory and non-sensory elements, the discussion extends to the role of endogenous factors such as gender, ethnicity, and microbiota diversity in shaping taste preferences. This sheds light on the microbial impact on sensory perception and its potential ramifications for dietary choices and health-related behaviors.

By exploring the interplay between taste phenotypes and endogenous factors, a more nuanced understanding emerges regarding how our palate shapes dietary decisions and health outcomes. This insight lays the groundwork for personalized approaches to nutrition and healthcare, tailored to individual taste profiles and physiological factors.

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S7-5 'Something to Chew On'; How a foods texture influences eating behaviour, Food Intake and Health

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Food choice and energy intake are more strongly influenced by the sensory and cognitive aspects of eating than the nutritive properties of the food being consumed. Prolonged consumption of dietary-patterns with poor nutrient quality result in diet-related chronic conditions such as obesity or type-2 diabetes, yet this knowledge is of little value if we cannot change these unhealthy food intake patterns. Sensory properties are central in shaping 'what', 'how much' and 'why' we eat, and influence the learning that drives our dietary-patterns to influence health. Not all calories are created equal, and food texture, taste and aroma direct food choices, inform our eating behaviours and through this influence meal size. Extensive evidence from children and adults shows a meaningful association between eating rate, energy intake and body composition, and the associated risk of food based non-communicable disease. Numerous population and experimental studies provide evidence that eating at a slower rate produces sustained changes in *ad-libitum* energy intake, and can influence body-composition and moderate our metabolic response to ingested nutrients. Recent evidence highlights the importance of food texture and energy intake rate (kcals/min) in moderating calories consumed from ultra-processed and minimally-processed diets. Understanding how texture combines with energy density to inform habitual eating rates creates opportunities to design foods that support long-term energy control and sustain satisfaction. Sensory interventions will make it possible to promote healthier eating behaviours and will inform the development of successful dietary strategies that keep food enjoyment and satisfaction at the heart of healthy eating.

S8-1 Genetic mechanisms underlying sweet, umami, and kokumi perception and preferences in the domestic cat, an obligate carnivore.

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Domestic cats (*Felis catus*) are obligate carnivores, and as such require a meat-based diet. The class C GPCRs incorporates several important taste receptors, including sweet (T1R2-T1R3), umami (T1R1-T1R3), and kokumi (CaSR). We have studied these taste receptors *in vitro* to determine their functionality and role in the taste perception of the domestic cat. It is long-established that cats are indifferent to sugars and sweeteners, but it was not until more recently that it was discovered that this was due to their sweet taste receptor gene (*Tas1r2*) being pseudogenised. It is proposed that cats lost their ability to taste sugar since they do not commonly encounter it in their carnivorous diet. Cats, however, have a strong preference for umami compounds such as nucleotides, amino acids, and their mixtures. Interestingly, the cat umami receptor responds to a range of nucleotides as agonists and several amino acids act as enhancers. These compounds are commonly present in meat and are highly appetitive for cats. Indeed, it has been proposed that umami is the main appetitive taste modality for the domestic cat. Cats also have a functional kokumi receptor, which has a high similarity amongst mammalian species, although there are differences in taste sensitivity. It is suggested that kokumi is an important taste modality for carnivores that also enhances the palatability of meat-derived compounds. Collectively, it appears the sense of taste of cats has evolved to detect compounds present in meat, which is their primary food source. Further details on these findings will be presented.

S8-2 The trilogy of human musk receptors: Linking receptor activation, genotype and sensory perception

Christel Merillat [1]

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The scent of musk plays a unique role in the history of perfumery. Musk odorants comprise six diverse chemical classes and perception difference in strength and quality among human panelists have long puzzled the field of olfaction research. Three odorant receptors (OR) had recently been described for musk odorants: OR5AN1, OR1N2 and OR5A2. High functional expression of the difficult-to-express human OR5A2 was achieved by a modification of the C-terminal domain and the link between sensory perception and receptor activation for the trilogy of these receptors and their key genetic variants was investigated: All three receptors detect only musky smelling compounds among 440 commercial fragrance compounds. OR5A2 is the key receptor for the classes of polycyclic and linear musks and for most macrocylic lactones. A single P172L substitution reduces sensitivity of OR5A2 around 50-fold. In parallel, human panelists homozygous for this mutation have an around 40 – 60-fold higher sensory detection threshold for selective OR5A2 ligands. For macrocyclic lactones, OR5A2 could further be proven as the key OR by a strong correlation between *in vitro* activation and the sensory detection threshold *in vivo*. OR5AN1 is the dominant receptor for the perception of macrocyclic ketones such as muscone and some nitromusks, as panelists with a mutant OR5A2 are still equally sensitive to these ligands. Finally, OR1N2 appears to be an additional receptor involved in the perception of the natural (*E*)-ambrettolide. This study for the first time links OR activation to sensory perception and genetic polymorphisms for this unique class of odorants.

S8-3 The liking and wanting model in pigs: taste-taste and taste-flavour interactions

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The perception of food-sensory cues is crucial to the regulation of eating behavior. Mammalian species share similar chemosensory mechanisms. However, appetite behavior patterns resulting from integrating complex stimulus around food may differ significantly across species. Species specific environmental and social factors such as the type of diet or maternal conditioning play a significant role in shaping eating behaviors. Several physiological and behavioral aspects highlight the relevance of the pig as a human model. These include an omnivorous diet, the size and functionality of the gastrointestinal tract (GIT), the main fermentation site located in the colon (like in humans but different from rodents which are cecal fermenters), and the high identity in chemosensory gene sequences and repertoire (except for bitter taste receptors) among other aspects. In addition, a model to assess “liking” and “wanting” behaviors in pigs was developed to study human-like behaviors such as preference for high carbohydrate (cereal-based) diets. The “liking” was based on a choice preference model while the “wanting” relates to measuring sensory-motivated intake of nutrients in a short 2-minute tests. A case study based on starch “liking” and “wanting” in pigs led to the discovery of taste-taste and taste-flavor interactions and the genetic background associated with high “wanting” of starch in pig behavior. In particular, the high preference and high “wanting” of starch-derived solutions was associated to sweetness perception whereas high responders to the solutions had a magnified capacity of stimulating taste sensory cells by transmembrane receptor activation and an upsized intracellular signal-transduction cascade.

S9-1 Odor mixing, dispersion, and sampling in olfactory landscapes

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Quantifying naturalistic olfactory stimuli at the sensor level is a multiscale fluid dynamics problem. From source to sensor, odor packets evolve continually under the dual influences of fluid dynamic strain and molecular diffusion. Strain arises from spatial velocity gradients and acts to enhance local concentration gradients, and in turn diffusion, in preferential directions. In complex environmental flows, the relative importance of these mechanisms is parametrized by the Reynolds and Péclet numbers. Along with the source configuration (mass flow rate, buoyancy, proximity to solid boundaries, size), these broadly set the statistics of concentration fluctuations arriving near a sensor. Additionally, active sensing schemes such as sniffing and antennal flicking can further modulate the stimulus by altering local flow and odor fields. Here, we discuss several projects from our lab within the context of the Odor2Action Network focused on i. experimentally quantifying naturalistic stimuli in turbulent odor plumes, ii. investigating the fluid dynamics of active sensation schemes, and iii. quantifying the statistical coupling of flow and odor cues as exploitable multimodal information during olfactory navigation. Towards these aims, we are acquiring state-of-the art wind tunnel plume measurements using simultaneous planar laser-induced fluorescence (PLIF) and stereo particle image velocimetry (sPIV), numerically modeling insect antennae and quantifying odor capture efficiencies, conducting tomographic PIV measurements around a sniffing mouse model, and using Lagrangian Coherent Structures (LCS) to elucidate coupled flow and odor structure in plumes. We highlight recent findings and research directions within each project.

S9-2 Active Sensing of Odors Through Antennal "Sniffing" Movements in the Honey Bee (Apis mellifera)

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Honey bees have filiform antennae that sense, among other types of stimuli, odors transmitted through turbulent plumes that honey bees track while walking or flying. While flying, honey bees hold their antennae in a fixed position to the sides of the head, and active sensing occurs through body movements. Walking honey bees move antennae in characteristic patterns, which we propose improve sensation of odors. We evaluated antennal movements placing restrained, naïve workers into a wind tunnel that carried odors in plumes with different statistical properties. In odorless air, honey bees bimodally positioned their antennae from an upwind position to one oriented more laterally across the flow. The statistics of these movements changed when plumes contained odor, and they were affected by different flow conditions. These results suggest that antennal movement serves odor detection. We next conditioned honey bees to an odor and compared responses to odors that had appetitive or aversive meanings. Honey bees oriented their antennae upwind when odors had been associated with reward. Reponses to other odors were biased toward the lateral position and did not change with the meaning of the odor. Furthermore, when the odor terminated, honey bees increased movement of the antennae. We interpret these changes in movement as odor 'exploitation' (toward the source) versus odor 'exploration' (when odor terminates). These movements highlight how honey bees move antennae to actively sense odors. We are now investigating how movements facilitate odor neural representations, and how they translate into natural situations.

S9-3 Ecology and plasticity in the olfactory search behaviors of mammals

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Navigating to odors is critical for survival and fitness of mammals, made challenging by constantly changing olfactory landscapes. Using mice as a model, great advances have been made in understanding the behavioral strategies used by mammals to locate odor sources in these landscapes, including klinotactic inter-sniff comparisons, stereo-olfaction, casting movements and cognitive learning strategies. But what happens when these strategies are disrupted, as may occur in natural ecological conditions? We used an open field odor-based spot finding task to examine how loss and regeneration of olfactory sensory neurons (OSNs) impacts mouse navigation strategies. Mice were treated with the drug methimazole, which selectively ablates the OSNs, resulting in temporary olfactory deficits. While mouse olfactory localization success decreased following methimazole treatment as predicted, our results also suggest that mice can adjust their search strategy to compensate for the loss of olfactory cues. This raises interesting questions on the external and internal variation mammals may experience when using odors to navigate under natural conditions. The strategies used by mammals to locate odor sources have primarily been described under terrestrial circumstances. I will also present data on the olfactory tracking

strategies used by Neotropical fruit bats when both crawling and flying. As flying mammals, bats face added challenges of aerial movement, high speeds and potential physiological constraints associated with echolocation. Insights from these different species and paradigms can help our understanding of how mammals navigate in a dynamic olfactory world.

S9-4 Mice can discriminate odour source distance using plume temporal dynamics

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The spatiotemporal dynamics of natural odour plumes shaped by airflow turbulence provide valuable cues about the location of odour sources. Recent experiments demonstrate that correlated odour intensity fluctuations arise when odours originate from the same source, while even a source separation of 50 cm results in uncorrelated odour profiles.

We here explored whether mice can use the spatial information carried by natural odour plumes to tell the distance of odour sources apart. Employing a wind tunnel and state-of-the-art odour delivery devices, we created and measured odour plumes, and replicated them in an "olfactory virtual reality".

By examining the temporal characteristics of odour plumes generated in the wind tunnel, we propose that features operating at frequencies higher than the respiratory cycle hold greater significance for the distance discrimination task compared to slower timescales, such as average concentration over a trial. Training mice in high-throughput behavioural conditioning tasks, we observed their ability to differentiate distances based on odour cues. Furthermore, by presenting odour plumes recorded at various distances in the virtual reality environment, we discovered that a subset of olfactory bulb projections neurons, Mitral and Tufted cells, exhibited differential responses corresponding to different distances. Notably, these responses were linked to the temporal features of odour plumes and showed correlations with sub-sniff temporal patterns.

Our findings highlight the mice's capability to extract and utilize complex temporal information carried by odour plumes for distance discrimination. On the cellular level, we shed light on the intricate mechanisms of olfactory source localization in olfactory bulb neurons.

S9-5 Odor encoding in the Drosophila navigation center

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Odors are one of the main cues used by insects to locate food resources. Our lab has been using fruit flies to understand how brain circuits are organized to translate odor information into navigation behavior. Our studies have led us to the fan-shaped body, a conserved part of the insect navigation center called the central complex. We have found that columnar and tangential inputs to this structure carry information about movement through space, and chemosensory context, respectively. Local neurons interconnect these inputs and can generate signals related to goals in the environment. In ongoing work, we are investigating the representation of chemosensory information across the array of ~150 tangential neurons. In addition, we are examining the dynamics of odor representations in fan-shaped body local neurons. Our data suggest that one function of local neurons is to integrate olfactory information over time to form a working memory that allows the fly to continue tracking when odor is momentarily lost.

S10-1 The Brain Mechanisms Behind the Chemistry in Social Chemistry

Inbal Ravreby [1]

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Nonhuman terrestrial mammals sniff themselves and each other to decide who is friend or foe. Humans also sniff themselves and each other, but the function of this is unknown. Because humans seek friends who are similar to themselves, we hypothesized that humans may smell themselves and others to subconsciously estimate body odor similarity, which, in turn, may promote friendship. To test this, we recruited nonromantic same-sex friend dyads and harvested their body odor. We found that objective ratings obtained with an electronic nose, and subjective ratings obtained from independent human smellers converged to suggest that friends smell more similar to each other than random dyads. We then recruited complete strangers, smelled them with an electronic nose, and engaged them in nonverbal dyadic interactions. We observed that dyads who smelled more similar had more positive dyadic interactions. In other words, we could predict bonding with an electronic nose. Next, to further probe causality, we manipulated participant body-odor. We generated rose-smelling and lavender-smelling participants (using Deo candies). Then, in fMRI, we exposed them to images and movies of potential friends with olfactometer-generated congruent or incongruent body-odor (rose or lavender). Finally, outside the scanner, participants rated the images, and performed a recognition test for pictures coupled with congruent or incongruent body-odor. We found odor-congruency-dependent processing, suggesting that self-body-odor may provide a template for the brain, such that humans subconsciously compare between their own body-odor and others', and the resultant similarity may underlie the chemistry in social chemistry.

S10-2 How do I smell thee? Let me count the ways: Olfactory cues predict judgments of friendship potential in live interactions.

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What factors predict friendship formation? 40 self-rated heterosexual, cisgender women judged the friendship potential of other women in the group based on *diplomatic* body odor alone (body odor including daily personal hygiene products and fragrance, presented on t-shirts), visual cues alone (portrait photographs presented for 100-ms), and during a 4-minute live interaction during a speed-dating-type event that we called speed-friending. Prior to the speed friending day, participants viewed photographs and answered questions about how interested they would be in interacting with each woman. On each day of the 2-day speed-friending event, women arrived in two groups of 10. They smelled the randomly numbered t-shirts from the other group and again judged each woman's friendship potential. During the speed-friending session, they met each woman and again made judgments. After the speed friending session concluded, the women smelled the same shirts of the women they had met and made one last round of judgments. Judgments based on t-shirts and on photographs uniquely predicted judgments of friendship potential in the live interactions. Moreover, the extent of liking in the speed-friending interaction predicted changes in the second round of odor judgments. These results demonstrate that social olfactory cues inform judgments of friendship potential during ecologically relevant interactions, and that visual and

olfactory cues provide complimentary but distinct information. Further, these results suggest that the perception of olfactory cues is modified by the valence of actual interactions, suggesting that olfactory cues may be involved in associative learning during the early stages of friendship formation.

S10-3 Attractiveness of human odor from different sources: influencing factors and relationship between body odor perception and its chemical composition.

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Although various factors (e.g. hormonal, genetic) have been showed to significantly affect body odor attractiveness, the underlying mechanisms remain unclear, and research to date has primarily focused on skin samples from the axilla. Knowledge about the chemical underpinnings of these effects could help understanding those mechanisms better. We studied a group of 115 males and females of different age groups (children, adults, elderly) who provided body odor samples from their neck and axilla, as well as salivary samples for testosterone dosage and HLA genotyping. Body odor samples were evaluated perceptually and were chemically analyzed with GC-MS analysis, thanks to a new collection device that we developed for this purpose (ABOV Analysis of Body Odor Volatiles). Differences related to age, sex, hormonal status (testosterone level in men, phase of the menstrual cycle in women), HLA characteristics (heterozygosity, dissimilarity) will be presented and perceptual and chemical data will be put into perspective.

S10-4 The Role of Testosterone in Odor-Based Perceptions of Social Status

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Awareness of the social status of conspecifics is essential for members of social-living species, including humans. Given that testosterone is thought to promote status motivation in humans, and may also alter body odor, the current research examines whether social status may be perceived through body odor cues associated with testosterone. Male scent donors (N = 74) provided salivary testosterone and scent samples on worn T-shirts. Female (N = 427) and male (N=370) raters smelled scents and provided ratings of the wearer's perceived social status (i.e., dominance and prestige). Ratings of dominance (but not prestige) were positively correlated with scent donors' testosterone levels. This result replicated in both female and the male raters. For females, the testosterone-dominance relationship was mediated by scent intensity. These results suggest that hormonally-based odor cues play a role in person perception and may serve as one modality through which information about status and personality are communicated.

S10-5 Olfactory cues to winning and losing in virtual reality game

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Dominance status formed by winning or losing a contest plays a key role in various social interactions. Human body odour contains cues to psychological dominance, competition and even competition outcome (a putative marker of a change in dominance hierarchy). Research with Mixed Martial Arts fighters has shown that the quality of body odour decreases after losing a match, with affective states mediating the change. Although real-life settings offer high ecological validity, they can introduce noise and obscure some effects. Therefore, this study investigated the effect of winning and losing a competition under more standardised conditions while simultaneously having a highly realistic and immersive environment using a first-person shooter game in virtual reality. We collected axillary odour samples from 46 men for 30 minutes in three situations: 1) before the game, 2) after winning a game, and 3) after losing a game (the order of winning and losing conditions was randomised). Subsequently, 113 men ranked obtained stimuli according to their dominance, pleasantness, and intensity. The results will be discussed in relation to olfactory cues associated with dominance-related characteristics and their potential mediating factors, such as affective states and steroid hormone levels.

S11-1 Fast updating feedback from the piriform cortex to the olfactory bulb relays multimodal identity and reward contingency signals during rule-reversal

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Animals adjust their behavior to adapt to relevant environmental changes, but the neural pathways enabling these changes remain unclear. Mice excel in discriminating odorants in complex sensory conditions. However, little is known about (**1**) how changes in stimulus contingency modify odor representations and (**2**) how updating odor representations is causally related to behavioral adjustments. The anterior piriform cortex(aPCx) sends dense feedback to the olfactory bulb (OB) and shapes, specifically the activity of mitral cells (MCs), one of the OB output channels. However, the role of aPCx feedback in shaping bulb output according to behavioral needs remains unclear.

To investigate the role of aPCx feedback in supporting flexible behaviors, we designed a novel Go/No-Go task with rule reversal guided by olfactory and auditory cues. Within the same session, stimulus-reward contingencies were reversed across blocks of trials. In parallel, we monitored the aPCx-to-OB feedback (GCaMP) using multiphoton microscopy. The aPCx feedback activity triggered by the task cues preceded the behavioral reporting(licking) and mirrored the reversals in stimulus-reward contingency throughout each session. Within seconds of each rule reversal, we observed the re-shaping of individual bouton responses to the same sensory cue in tight correlation with the behavioral output switch. Optogenetic perturbation of the aPCx feedback within the OB(Jaws) disrupted the behavioral performance.

Our results indicate that the aPCx-to-OB feedback multiplexes stimulus identity and reward contingency signals and is rapidly re-formatted according to changes in the behavioral output. In ongoing experiments, we analyze the interplay between OB feedforward and aPCx feedback signals supporting behavioral flexibility.

S11-2 Odor Representations by Individual Neurons in the Human Brain

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Olfactory research mainly relies on animal models and non-invasive human imaging studies, leading to a significant gap in understanding neural coding mechanisms in humans. We present the first direct recordings from the human primary olfactory cortex and medial temporal lobe during an odor-rating and identification task. We discover odor-modulated neurons in the human piriform cortex, amygdala, entorhinal cortex, and hippocampus. Neurons in these regions precisely encode odor identities. Importantly, we demonstrate region-specific effects of central repetition suppression and habituation. We further unveil a prominent decrease in neural responses from the first to the second odor presentation, specifically in the piriform cortex. Our odor-rating and identification task links human olfactory processes, such as semantic odor identification and reported odor valence, to neuronal activity along the olfactory pathway, allowing us to identify region-specific functions. We find that amygdala neurons encode personal valence ratings, whereas hippocampal neurons predict odor-identification performance. Notably, we reveal that individual neurons in the human piriform cortex precisely encode the identities of odor-related images, highlighting multimodal sensory functions of the human piriform cortex. Presenting semantically related images and odors, we find significant cross-modal coding, especially in the amygdala and the piriform cortex. Most strikingly, we discover individual neurons firing in response to both odors and semantically related images, suggesting concept-like neural coding schemes in olfaction. By bridging the gap between animal models and human research, our results provide unprecedented insights into human olfactory processing, revealing neural odor coding principles, regional functional specificity, and cross-modal sensory integration.

S11-3 Cell type-specific bidirectional neuron-astrocyte communication contributes to information processing in the mouse olfactory bulb

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Astrocytes not only support neurons and tissue homeostasis, but also ensheath synapses with microdomains and directly interact with pre- as well as postsynaptic compartments. Adenosine triphosphate (ATP), the major messenger molecule involved in neuron-astrocyte communication, is released at axo-dendritic synapses and stimulates perisynaptic astrocyte microdomains. In addition, ATP is released from astrocytes and affects adjacent neurons and astrocytes. Here, we studied purinergic interactions between reciprocal dendro-dendritic synapses and astrocytes in the external plexiform layer

of the olfactory bulb. Reciprocal synapses are composed of glutamatergic release sites of mitral and tufted cells on the one side facing GABAergic release sites of granule cells on the other side. Electrical and optogenetic stimulation of granule cells resulted in Ca^{2+} transients in GCaMP6s-expressing astrocytes, whereas stimulation of mitral/tufted cells did not excite astrocytes. Stimulation-evoked Ca^{2+} signals in astrocytes were strongly reduced by antagonists of $P2Y_1$ (MRS2179), and A_{2A} receptors (ZM), while glutamatergic and GABAergic antagonists had only a minor impact. We expressed channelrhodopsin-2 in astrocytes to study the effect of astrocyte activation on neuronal activity. Photostimulation induced Ca^{2+} transients in astrocytes and resulted in an increase in neuronal network activity, as well as depolarization and action potential firing in mitral/tufted cell. Astrocyte-mediated neuronal excitation was inhibited by glutamatergic and purinergic antagonists, indicating glutamate and ATP release from astrocytes. The results indicate that granule cells, but not mitral/tufted cells release ATP that triggers an increase in Ca^{2+} in astrocytes, which then excite neuronal network activity in the olfactory bulb by glutamate/ATP release.

S11-4 Synaptic properties of the nucleus of the lateral olfactory tract.

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The sense of smell is tightly linked to emotions, a link that is thought to rely on the direct synaptic connections between the olfactory bulb and nuclei of the amygdala. A small number of amygdaloid nuclei are the recipients of such direct input from the olfactory bulb and their unique functions are not known. Among them, the nucleus of the lateral olfactory tract (NLOT) is unique in its developmental history and gene expression. NLOT has been very little studied and consequentially its function is unknown. Furthermore, formulation of informed hypotheses about NLOT function is at this stage limited by the lack of knowledge about its connectivity and physiological properties. Here, we used pseudo-rabies tracing methods to systematically reveal monosynaptic inputs into NLOT, and adeno-associated viruses to reveal NLOT projection targets. We found that the NLOT is interconnected with several olfactory brain regions and with the basolateral amygdala. Some of these connections were reciprocal, and some showed unique interhemispheric patterns. We tested the excitable properties of NLOT neurons and the properties of each of the major synaptic inputs. We found that the NLOT receives powerful input from piriform cortex, tenia tecta, and the basolateral amygdala, but only very weak input from the olfactory bulb. When input crosses threshold, NLOT neurons respond with calcium-dependent bursts of action potentials. This integration of olfactory and amygdalar inputs may underlie a role in behaviors that combine smell and emotion.

S11-5 Control of innate olfactory valence by topographically segregated cortical amygdala circuits

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Innate behaviors are stereotypical between animals and likely result from genetically determined and conserved circuits. In mice, the cortical amygdala (plCoA) mediates innate attraction and aversion to odor, however, little is known about how this brain area gives rise to behaviors of opposing motivational valence. Here, we identify the cell types and circuits underlying these innate responses. First, a topographic organization for valence was revealed along the anterior-posterior axis in the plCoA, by

optogenetic stimulation, whereby the anterior and posterior regions elicit aversion and attraction, respectively. Using single-cell RNA sequencing, we find that there is a corresponding gradient in expression of VGluT1 and VGluT2 genes. Optogenetic activation of these respective cell types recapitulates appetitive and aversive behaviors. Lastly, we identified the a topographically organized circuit of projections from the plCoA, whereby anterior neurons project to the medial amygdala and posterior neurons preferentially project to nucleus accumbens, which are respectively necessary and sufficient for avoidance and approach responses. Together, these data advance our understanding of how the olfactory system generates, innate attraction and aversive to odor, and supports a model where distinct, hardwired, topographically distributed plCoA populations direct innate olfactory responses by signaling to divergent valence-specific targets, linking upstream olfactory identity to downstream valence behaviors.

S11-6 The cortical neuronal activity in mice with genetically ablated olfactory bulbs

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Olfaction relies on transmission and processing of odorous information through several cortical structures the largest of which is the piriform cortex (PCx) which is assumed to be essential in odor identification. In a recent study, we showed that despite a severe atrophy of an olfactory bulb (OB), caused by an early developmental manipulation of vascular endothelial growth factor (VEGF), mice with as little as 10% of a normal OB retain a surprising sensory capacity for olfactory guided behavioral tasks. Here we investigate how the neural activity and olfactory coding in the PCx is affected by OB degeneration.

We used multielectrode arrays to record the extracellular activity of neurons within the PCx in awake mice with degenerated OBs and in control mice, and compared several parameters of both spontaneous neural activity and odor responses. Surprisingly, the PCx of mutant mice was remarkably similar to the control mice in both baseline and odor evoked neural activity. Those findings suggest a compensatory plasticity in the neural pathway from the olfactory epithelium to the olfactory cortex.

S12-1 Pervasive sublethal effects of agrochemicals as contributing factors to insect decline

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Insect biomass is declining across the globe at an alarming rate. Climate change and the widespread use of pesticides have been hypothesized as two underlying drivers. However, the lack of systematic experimental studies across chemicals and species limits our causal understanding of this problem. Here, we employed a chemical library encompassing 1024 different pesticides to investigate how insect

populations are affected by varying concentrations of these molecules, focusing on sublethal doses. Using a controlled laboratory pipeline for Drosophila melanogaster, we found that 57% of these chemicals affect the behavior of larvae at sublethal concentrations, and an even higher proportion compromises long-term survivability after acute exposure. Consistent with these results, we observed that exposure to chemicals at doses orders of magnitude below lethality induced widespread phosphorylation changes across the larval proteome. The effects of agrochemicals were amplified when the ambient temperature was increased by four degrees. We also tested the synergistic effects of multiple chemicals at doses found widely in nature and observed fitness-reducing changes in larval developmental time, behavior, and reproduction. Finally, we expanded our investigation to additional fly species, mosquitos, and butterflies and detected similar behavioral alterations triggered by pesticides at sublethal concentrations. Our results provide experimental evidence that strongly suggests sublethal doses of agrochemicals coupled with changes in environmental temperatures are contributing to the global decline in insect populations. We anticipate that our assays can contribute to improving chemical safety assessment, better protect the environment, secure food supplies, as well as understand our rapidly changing world.

S12-2 Spider olfaction: as sensitive as in insects

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While the vision and vibration sensing of spiders are well known, their sense of smell is poorly understood. Behavioral evidence demonstrated that some male spiders could detect the volatile sex pheromones released by female conspecifics from a distance. However, it is still a mystery how they smell the volatiles, as previous studies suggested that spiders only have tip-pore sensilla (considered gustatory) on their appendages and lack wall-pore sensilla (olfactory). A better understanding of the olfaction in spiders is necessary to gain insights into how these vital components in the ecosystem perceive the chemical cues and signals in the environment. In this study, we investigated the orb-weaving spider *Argiope bruennichi* for which the female sex pheromone attractive to males is known. We detected wall-pore sensilla (WPS) on all walking legs of the males of *A. bruennichi*. The WPS occur in areas that do not contact the substrates, in contrast to tip-pore sensilla. Recordings from single wall-pore sensilla showed that the neurons responded to the sex pheromone in a concentration-dependent manner, with a sensitivity comparable to that of highly sensitive insect olfactory neurons. Our results illustrated that male spiders are equipped with olfactory sensilla, enabling them to find mating partners from a distance.

S12-3 Elevated levels of ozone compromise insect pheromone communication

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Insects utilize pheromones to enhance their mating success and maintain reproductive boundaries among closely related species. However, the insect's pheromone communication system, which evolved from pre-industrialization, faces challenges in the Anthropocene, particularly due to the increased level of oxidizing air pollutants like ozone that can degrade carbon double bonds in many pheromones. In here, we investigated how increasing concentrations of ozone affect the pheromones and mating behaviors in *Drosophila* flies. We observed a significant reduction in pheromone levels after short exposure to 100ppb

ozone, a common concentration in polluted areas. Consequently, females exhibited reduced mating interest in ozone-exposed males. Furthermore, males could not discriminate ozone-exposed males from females and displayed male-male courtship behavior. Additionally, pheromones play a crucial role in maintaining mating boundaries among sibling species. Our findings indicate that ozone-induced decrease of pheromones in *Drosophila melanogaster*, *D. simulans*, *D. mauritiana*, and *D. sechellia*, can lead to hybridization between some of these species. Given that many resulting hybrids are sterile, increased hybridization poses an evolutionary disadvantage and could lead to local population decline. In summary, Anthropocenic ozone can oxidize carbon double bonds in pheromones, resulting both in a corrupted intra-specific sex communication and in the breakdown of mating boundaries among closely related species.

S12-4 Mosquito adaptation in the anthropocene: effects of elevated carbon dioxide levels and extended egg quiescence in Aedes aegypti

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Elevation in atmospheric carbon dioxide has been one of the major drivers of anthropogenic climate change. The increase in atmospheric carbon dioxide can significantly change the water biochemistry, adversely affecting the residing organisms. *Aedes aegypti* lay eggs in ephemeral water bodies that are prone to desiccation, and the eggs have evolved to withstand periods of dormancy. Extended egg quiescence has been shown to affect the gaseous exchange across the chorion, as well as larval susceptibility to abiotic stressors. In this study, we investigated the combined effect of elevation in carbon dioxide and extended egg quiescence on the life history traits of immature stages and adults. Elevated carbon dioxide levels, combined with extended egg quiescence, adversely affected larval survival and developmental duration. Furthermore, this stress had carry-over effects on adult survival and body size. We also investigated the metabolic reserves of the newly emerging females and assessed how this affected differential feeding on a carbohydrate-rich or protein-rich meal. Teneral females had differentially variable metabolic reserves and showed differential resource feeding in response to being reared under different carbon dioxide levels and whether the mosquitoes emerged from eggs with either a short or long quiescence period. Ongoing work, aims at examining how these conditions affect gene expression in the olfactory sensory system of the female, using transcriptome analysis. In the face of changing environmental conditions, the duration of egg quiescence can have serious implications for *Ae. aegypti* survival, population dynamics and vectorial capacity.

S12-5 The role of styrene, an unusual natural product, in bark beetle-fungus interactions

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The Eurasian spruce bark beetle, *Ips typographus,* is a lethal pest for Norway spruce (*Picea abies*) throughout Europe, mainly due to its association with a suite of ascomycete blue-stain fungi. These fungi, differing in virulence, can exhaust or overwhelm tree chemical defences leading to tree death. Recent studies indicate that a highly virulent fungus changes the volatile profile of spruce trees, aiding beetles to

identify trees colonised by beneficial fungi. While symbiotic fungi are known to degrade non-volatile defence chemicals, it remains unknown whether any resulting byproducts could function as insect semiochemicals.

This study investigated whether bark beetles could differentiate the virulence of fungi based on their volatile profile and utilise these cues to select fungi. Analysis revealed that a symbiotic fungus produces styrene by metabolising non-volatile *trans*-cinnamic acid from the host tree- a key intermediate in the biosynthesis of spruce chemical defences. While *trans*-cinnamic acid was not toxic to beetles, it inhibited symbiotic fungal growth. Adult beetles possess specific olfactory sensory neurons to detect styrene and other similar chemicals. Short-range behavioural assays using walking beetles demonstrated that beetles are attracted to styrene-producing fungi. However, long-range field trapping experiments showed that styrene inhibited the attraction of beetles to pheromones. Altogether, this study demonstrated that beetles use specific volatile cues derived from the fungal metabolism of a key intermediate compound in spruce defence biosynthesis to identify and differentiate virulent from less-virulent fungi. This association with virulent fungi potentially enables beetles to avoid toxic tree chemicals, ultimately increasing their fitness.

S13-1 Exploring solitary and social odor sampling with machine learning

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Here I review challenges in characterizing natural animal behavior in the lab, with particular focus on active sensing in olfaction. I will review issues related to stimulus control and the measurement of sampling, and present data in which we use the Motion Sequencing platform to better understand the relationship between active odor sampling and three-dimensional mouse movement. Finally, I will highlight promising approaches to interrogating sensorimotor olfactory loops during solitary and social behavior.

S13-2 More than familiarity? The impact of social olfactory communication in zebra finches

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Studies across the animal kingdom have shown that body odours are predestinated to encode information about genetic similarity or relatedness, and thus allow individuals to recognize kin. Birds have long time been an exception to this rule, as birds in general and songbirds in particular have been assumed to lack a well-developed sense of smell. Instead, familiarity, or learning through association, e.g. sharing the same nest environment, have been assumed to be the main driver of kin recognition. Recent studies, however, have proven that (i) even songbirds have a well-developed sense of smell and (2) are capable of olfactory kin recognition in the absence of prior association. Here I present a series of experiments in which we tested zebra finches and Bengalese finches for their ability of olfactory kin recognition and the impact of this information on later life.

S13-3 Social regulation of sting alarm pheromone responsiveness in honeybees

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Honeybees defend their nest against large predators thanks to a collective effort to harass and sting the intruder. Typically the threat is detected by a few bees, which then need to quickly mobilize their nestmates into a defensive response. At the core of this recruitment is the sting alarm pheromone (SAP), a complex odour blend released when the bees' stinger is exposed. The SAP attracts and primes nearby workers for attack, thus providing a seemingly simple communication channel during defensive events. However, when taking a closer look at this system we found that the decision to sting of bees receiving this signal was dependent on a number of social factors. Group size plays a major role in regulating stinging behaviour and responsiveness to SAP, whereas individual behaviour was relatively stable when group composition was altered. Finally, honeybees responded differentially to SAP as a function of both their age and their task: young (<10 days) and old (>30 days) bees had an increased likelihood to sting in the presence of SAP, irrespective of their task. Middle-aged (11-29 days) bees, however, only responded by stinging if they were foragers. Middle-aged nurses did not sting in response to SAP exposure. Overall, our results suggest that recruitment by SAP is a finely-tuned mechanism that is regulated on several timescales. Our next challenge will be to understand the neurobiological processes underlying this social modulation of SAP responsiveness.

S13-4 How social cues can guide individually navigating ants

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The desert ant, *Cataglyphis fortis*, thrives under the harsh conditions of Tunisia's saltpans, where extreme environmental challenges and scarce food resources demand efficient navigation strategies. Unlike species that forage collectively, these ants are solitary foragers, primarily relying on path integration for navigation. Despite the efficacy of path integration, it is susceptible to errors. To enhance accuracy, these ants also rely on visual and olfactory cues for locating their nest entrances. Here, we explore how social cues can influence their navigational processes, with a focus on two key aspects. Initially, we show that ants increase their nest hill height in featureless saltpan areas to improve nest entrance location. This behavior, resulting from collaboration between foraging ants and nest builders, acts as a navigational aid, indicating social communication aimed at improving the colony's navigation efficiency. Furthermore, we investigate how interactions with non-nestmate ants influence foraging ants' search patterns, suggesting these encounters act as indirect social landmarks. Both cases illustrate how desert ants incorporate social information into their otherwise individual navigational strategies.

S13-5 Social context-dependent cannibalistic behavior in Drosophila larvae

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All animals must make appropriate, but also flexible, foraging decisions, especially when food availability is scarce or when facing starvation. *Drosophila* larvae need to eat throughout their life to pupate, eventually become a fly, and mate. It has been shown that they can even feed and survive on a conspecifics diet when no other food is present. We investigated how fly larvae sense each other and if the same sensory systems are involved in cannibalistic behavior. We find that alive and dead larvae

provide different multisensory cues, for example, chemosensory and mechanosensory. We further investigated under which circumstances fly larvae turn to cannibalism and how internal state and social context influence these foraging decisions. We can show that a group of fed larvae shows a weak preference for dead conspecifics, however, this preference can be enhanced by starvation. Furthermore, we find that a single alive larva shows an enhanced preference for dead conspecifics even when fed, thus social group context prevents cannibalistic behavior. We hypothesize that a cannibalistic context provides the presence of a potential food source, but also the danger of being eaten. We are investigating how larvae integrate social multisensory cues with internal state and how this modulates feeding on conspecifics. Flexibility in foraging behavior enables fly larvae to optimally weigh food availability vs. threat in a foraging situation and to expand their feeding choices to overcome starvation.

S14-1 Olfactory epithelium stem and progenitor cells

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Neurogenesis persists in the adult olfactory epithelium, supported by basal epithelial stem and progenitor cell populations. To maintain olfaction, olfactory epithelial cell populations must be properly replenished following damage. Rodent models have defined key aspects of this process, identifying distinct roles for globose basal cells and reserve horizontal basal stem cells to reconstitute the neural and non-neuronal epithelial populations following experimental lesion. We discuss analysis of the functional subpopulations of basal stem and progenitor cells, and mechanisms regulating their activity. Approaches to the study of olfactory basal stem cells in adult humans are considered, including single cell assays and in vitro models. Human biopsy assays pose additional challenges, such the occurrence of respiratory-like metaplasia, and the presence of both olfactory and respiratory basal cells. Insights from comparisons of health and disease conditions impacting the olfactory epithelium are discussed.

S14-2 Onset and time course of odorant receptor gene expression in the developing olfactory epithelium of the mouse

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The perception of odors begins with the interaction between odorants and odorant receptors (ORs) expressed by olfactory sensory neurons (OSNs) located within the nasal cavity. In the mouse, the OR gene repertoire comprises 1149 intact OR genes. It is widely believed that a single mature OSN expresses a single intact OR gene at high level, and in a monoallelic fashion. The onset and time course of expression of the OR gene repertoire have not been extensively investigated during mouse development. Here, we have investigated the expression of 1047 OR genes in the olfactory mucosa from the formation of the olfactory placode at embryonic day 8.5 to postnatal day 0.5. We detected expression of OR genes by NanoString technology as early as embryonic day 8.5, and confirmed expression by *in situ* hybridization from embryonic day 11.5. We identified coexpression of OR genes in some cells located in the mesenchyme and the prospective olfactory epithelium.

S14-3 Regulation and Diversity of Adult Neural Stem Cells

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Neural stem cells reside in specialized niches in the adult mammalian brain and contribute to brain plasticity throughout life. The adult ventricular-subventricular zone (V-SVZ) adjacent to the lateral ventricles is the largest germinal niche in the adult mouse brain. Stem cells in the V-SVZ give rise to different subtypes of olfactory bulb interneurons, as well as to some glia. Importantly, adult V-SVZ neural stem cells are a heterogeneous population, with distinct molecular identities and fates, depending on their spatial location in the niche. They constantly integrate intrinsic and extrinsic signals to either maintain their quiescent state or to become activated to divide and generate progeny. However, the functional significance of this heterogeneity has remained elusive. I will present our recent findings highlighting the key role of physiological states in regulating regionally distinct pools of adult neural stem cells for on-demand neurogenesis, including the coordinated recruitment of specific pools of adult V-SVZ neural stem cells in mothers during pregnancy. This leads to the generation of distinct subtypes of short-lived interneurons that integrate into the olfactory bulb around birth and are largely culled around weaning. These transient neurons are important for mothers to recognize their own pups. Thus, adult neural stem cells provide an important substrate for adaptive brain plasticity in anticipation of upcoming physiological needs.

S14-4 Comparative Neurogenesis of Piriform Cortex and Tubular Striatum

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Olfactory information is processed into cognitive percepts in the cortical piriform cortex (PC) and subcortical tubular striatum (TuS) (formerly the olfactory tubercle). These regions arise from different embryonic structures, a developmental process involving a variety of cellular, molecular, and genetic mechanisms that are largely unknown. Using injections of thymidine analogs, we documented dual *inside-out* + *outside-in* gradients of neuronal generation in PC and a *lateral-to-medial* gradient in TuS. Tracing neuronal progenitor lineages from the lateral ganglionic eminence (LGE), using the piggyBac transposon, revealed a laminar determination of projection neurons based on progeny relationships in PC. These neurons followed a posterior to anterior gradient of cell migration. In TuS, we demonstrated that projection neurons arise from the ventral LGE, as occurs with all other neurons forming the striatum, confirming the striatal nature of TuS. Additionally, neuroblasts from PC and TuS followed separate migratory routes determined by different palisades of radial glial scaffolds originating in the LGE. Collectively, our data sheds light on the developmental mechanisms that shape the olfactory areas of the brain, contributing to a better understanding of the formation of circuits involved in odor coding.
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S15-1 Distinct and shared traits of taste buds across anatomical locations and species uncovered by single-cell transcriptomics

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Taste buds, located in the epithelia of the oral cavity and pharynx, consist of diverse taste cells, subsets of which respond to chemical substances. Various ways to categorize taste cells have been proposed in mice. While these categorizations have advanced our understanding of taste bud physiology, the full extent of taste cell diversity remains unexplored. Although regional differences in the cellular composition of taste buds are recognized, comprehensive cross-regional comparisons have yet to be performed. Furthermore, the similarities and differences in taste cell diversity across species, as well as the molecular mechanisms of taste cell diversification are still not fully understood.

In this study, we employed single-cell transcriptomics to gain unbiased insights. We conducted full-length single-cell RNA sequencing on fungiform, circumvallate, and hypopharyngeal taste buds of mice. Unsupervised clustering revealed a variety of taste cell types across locations, highlighting differences in cellular complexity. Despite similarities, fungiform taste buds displayed the greatest complexity, whereas hypopharyngeal taste buds had the fewest cell types. Specifically, taste cells mediating sodium taste (sodium cells) are present exclusively in fungiform taste buds. The knockout of one of transcription factors enriched in these cells specifically reduced the sodium cell population, identifying a molecular factor for their development. Comparative transcriptome analyses between rodent and primate taste buds revealed unique and shared characteristics in their cellular diversity and gene expression profiles. In light of single-cell transcriptomic data, we will discuss regional and interspecies differences in taste bud functionality, as well as the fate specification programs of taste cells.

S15-2 Shedding light on opsins: a new class of taste receptor

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Rhodopsin was discovered in the late 19th century, and no G-protein coupled receptor has undergone greater scrutiny. For >140 years it was thought that opsins function exclusively in light sensation. However, using *Drosophila*, we uncovered multiple, light-independent roles for opsins including detection of bitter tastants. We have now discovered that opsins represent a class of taste receptors that are evolutionarily conserved from fruit flies to mosquitoes, mice and humans. In mosquitoes, mice and humans, opsins are expressed in taste receptor cells, and are directly activated by flavonoids. In mice, *OPN3* is expressed in type II taste receptor cells, and mutant mice missing *OPN3* are impaired in their responses to multiple flavonoids. Given the >700 million years that have elapsed since insects and mammals shared a common ancestor, our findings establish opsins as an unexpected and ancient class of taste receptors in animals.

S15-3 Multiple taste qualities are transduced by the ion channel OTOP1

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To detect and discriminate among potential foods before ingestion, animals use a constellation of sensory receptors tuned to biologically important chemicals and expressed in taste receptor cells. One class of stimuli detected by taste cells is acids, which evoke a sour taste in humans. Previously we used RNAseq from taste cells to identify a novel proton channel, OTOP1, that is specifically expressed in sour (Type III) taste receptor cells and required for activation of taste receptor cells and gustatory nerves to acid stimuli. Thus, OTOP1 can be considered the sour receptor. However, Otop1 knockout mice do not display deficits

in behavioral responses to acid stimuli, suggesting OTOP1 may subserve other sensory functions. In addition to acids, Type III taste receptor cells respond to ammonium chloride, which alkalinizes the cell cytosol. We find that OTOP1 is required for responses of taste receptor cells and gustatory nerves to ammonium chloride, and sensitive behavioral aversion. We further show that a highly conserved amino acid is required for activation of the channel by ammonium chloride but not acids. These data suggest that OTOP1 evolved as a gustatory sensor to detect compounds that elicit changes in either extracellular or intracellular pH. Ammonium chloride, which is found around volcanos, has long been used as a control stimulus in gustatory nerve recording and is enjoyed in Scandinavian and Northern European countries in a confection called salty licorice (Salmiakki). Funded by NIDCD R01 R01DC013741.

S15-4 New Insights into Old Taste Cells

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Taste buds comprise 50-100 taste cells that are renewed repeatedly throughout the life of an organism. Progenitor cells near the base of the taste bud give rise to three mature taste cell types—Type I, II, and III cells—which continually repopulate the bud. As new cells enter, older cells disappear from the taste bud. Relatively little is known about the process of taste cell death and disposal. Here we present anatomical evidence of dying taste cells in murine circumvallate taste buds from datasets acquired by Serial Block Face Scanning Electron Microscopy (sbfSEM) (see Yang et al., 2020). This process allows for the segmentation and digital reconstruction of cellular and subcellular features within a large volume. We can identify dying cells by morphological hallmarks of apoptosis, including swollen ER, disruption of the nuclear membrane, and ultimately cellular fragmentation. In later stages, these cells appear to be engulfed by neighboring Type I taste cells, which contain large lysosomes. The large majority (>70%) of dying cells are Type II cells although Type I cells are the majority of cells within a taste bud. Hence, Type I cells are underrepresented in our dying taste cell population, which raises questions as to whether and/or how Type I cells die and exit the taste bud. These data show apoptosis as a typical method of taste cell death, and present a new role for Type I taste cells in the engulfment and degradation of dying cell materials.

S16-1 Structural basis of odorant recognition by a human odorant receptor

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Our sense of smell enables us to navigate a vast space of chemically diverse odour molecules. This task is accomplished by the combinatorial activation of approximately 400 odorant G protein-coupled receptors encoded in the human genome. How the diverse chemical features of odorants are recognized by odorant receptors remains unclear. We have recently determined the structure of the human odorant receptor OR51E2 bound to the fatty acid propionate, revealing central determinants of odorant recognition and receptor activation by odorants. In parallel, we are developing new approaches to interrogate the structure-function relationship of odorant receptors by employing large-scale deep mutational scanning. Together, our studies provide the first high-resolution views of chemical recognition of an odorant by a vertebrate odorant receptor and a framework to understand how odors turn on odorant receptors to enable our sense of smell.

S16-2 Structural basis of diverse chemical recognition by type 1 taste receptors – from organic compounds to ions

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Type 1 taste receptors (T1rs) serve as sweet and umami taste receptors in humans and are responsible for the gustatory sensation of organic nutrients such as sugars, amino acids, and nucleotides in many vertebrates. The structural basis of chemical recognition by T1rs is understood by the ligand-binding domain (LBD) of T1r2a/T1r3 from medaka fish, currently the sole T1 heterodimer available for protein-level structural and functional analyses. Based on the crystallographic structure, the amino-acid binding site in T1r2a/T1r3 was found to accommodate a variety of the substituent group of amino acids while strictly recognizing the common functional groups of amino acids, i.e. the α-amino and carboxy groups, which explains the broad substrate specificity of this receptor. In addition, we identified a chloride binding site allosteric to the amino-acid binding site in the common heterodimeric subunit, T1r3. We verified the binding of chloride ions to T1r2a/T1r3LBD and revealed that the chloride binding induces a conformational change of the LBD similar to those induced by the amino-acid binding. The chloride-binding site is likely conserved among T1r3s in many other species, including humans and mice. We confirmed that chloride ions induce a preferable taste sensation via T1rs in mice. Intriguingly, it has been reported that low salt concentrations of table salt are perceived as sweet by human panels. These observations might be consistent with the chloride sensation via T1rs and thus suggest the diverse chemical recognition property of T1rs from organic compounds to ions.

S16-3 Structural insights into insect olfactory receptors

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Olfactory systems must detect and discriminate an enormous diversity of chemicals in the environment. To contend with this challenge, diverse species from humans to insects, have converged on a common strategy in which odor identity is encoded through the combinatorial activation of large families of olfactory receptors, thus allowing a finite number of receptors to detect an almost infinite chemical world. Central to this sensory coding strategy is that most individual receptors can be activated by a variety of structurally and chemically diverse odorants, suggesting that odorant detection does not adhere to the classic lock and key mechanism that governs many receptor-ligand interactions. Our lab has been using the insect olfactory system as a window into the structural logic of odor detection. Insects have evolved a large and highly divergent family of odorant receptors, each with distinct chemical tuning. I will discuss recent experiments that shed light on the architecture, function, and evolution of this receptor family that facilitate the ability of insects to navigate a complex chemical world.

S16-4 Deciphering Odor Recognition: Structural Studies of G-Protein Coupled Odorant Receptors

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The mammalian olfactory system uses odorant receptors (ORs) to differentiate a wide array of odors, but the specific recognition mechanisms of these receptors are not fully understood. These receptors, part of

the G protein-coupled receptor (GPCR) family, detect and distinguish odorants with diverse physicochemical properties and molecular configurations. The OR family includes Class I ORs, sensitive to carboxylic acids and Class II ORs, which respond to various odorants and form the majority of mammalian ORs. Our research aims to elucidate how odorants bind to ORs. Using cryo-EM, we previously analyzed the activated structure of human OR51E2 bound to propionate, providing insights into Class I OR interactions with carboxylic acids. We now explored Class II OR interactions using a consensus protein design strategy, synthesizing engineered ORs that represent specific subfamilies by incorporating the most frequent amino acid at each position. This approach enabled the expression and purification of these ORs in heterologous systems, allowing us to determine cryo-EM structures for three distinct Class II ORs with their respective odorants. These structures reveal the unique ligand recognition properties of Class II ORs and highlight both shared and distinct features of their odorant-binding pockets compared to Class I ORs. Together with functional analysis of point mutants and computational simulations, our studies provide a framework for understanding molecular recognition by ORs, offering insights that pave the way for further research into odor recognition.

S17-1 Perceptual constancy for an odour is acquired through changes in primary sensory neurons

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The ability to consistently recognise an object despite variable sensory input is termed perceptual constancy. This ability is not innate, rather it develops early in life yet little is known about the neural processes underpinning its development.

We have taken advantage of the olfactory system of mice and using behavioural tests show that, when mice are naïve to an odour, perceptual constancy is not maintained for an odour across increasing concentration. 2-photon imaging of neural activity in the olfactory bulb revealed that the perceptual change coincides with a rapid reduction in activity in a single glomerulus that is most sensitive to the odour. This drop in activity is not a property of circuit interactions within the olfactory bulb; it is already present in the olfactory sensory neurons. Computational modelling shows that the rapid adaptation at higher concentrations is due to a sensitivity mismatch of olfactory receptor neurons resulting in transmission failure from the nose.

We then show that upon forming an association of this odour with food, mice perceive the odour as the same object across the whole range of concentrations tested. Correspondingly the sensitive glomerulus no longer displays rapid adaptation, due to a large sensitivity shift that matches its dynamic range to that of the food odour, when transmission failure is prevented, perceptual constancy is maintained. This work shows that the plasticity of the primary sensory organ enables learning of perceptual constancy.

S17-2 Heterogeneity and plasticity of dopaminergic neurons in the mouse olfactory bulb

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The mouse olfactory system serves as an ideal model for investigating activity-dependent neuronal plasticity mechanisms in response to sensory perturbations and associative learning. Bulbar dopaminergic (DA) neurons, known for their remarkable plasticity, are of particular interest due to their

capability for lifelong regeneration. However, their precise role in modulating olfactory information transfer and shaping behaviours like odour sensitivity and discrimination has been contentious, partly due to their historical treatment as a homogeneous population while they in fact exist as two distinct subgroups. DA neurons can be cleanly classified based on axonal morphology and developmental profiles: anaxonic DA neurons with adult neurogenesis potential and axon-bearing DA cells exclusively born embryonically. These subgroups, which differ in terms of connectivity, excitability, and odour tuning, also exhibit differential responses to sensory deprivation, with some undergoing structural and excitability changes while others rely on synaptic modifications. This plasticity surpasses that observed in excitatory neurons, suggesting their role in providing rapid circuit adaptation for sensory processing. This talk will outline our current research, which aims to elucidate how these distinct responses contribute to generating appropriate neuronal outputs at both network and behavioural levels.

S17-3 Olfactory Landscapes: deciphering scents through neural codes

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Sensory systems are organized hierarchically. Early stages format transduced signals, and successive processing steps perform complex computations to extract relevant sensory representations. This feedforward hierarchy is broken by cortical projections that terminate in early processing areas. In the olfactory system, the descending inputs from the cortex vastly outnumber the afferent received from the sensory periphery. Therefore, revealing how these projections contribute to the coding of complex stimuli, including odorant concentrations and their mixtures, is necessary to understand sensory processing. We expressed the calcium indicator GCaMP6f in the anterior piriform cortex and used multiphoton imaging to measure the stimulus-response properties of cortical projections to the olfactory bulb (OB) in awake mice. We used two sets of odorant stimuli that revealed surprising aspects of how odorants and their mixtures are represented in cortical projections to the OB. First, monomolecular odorants evoked responses in feedback projections that, as a population, reflected concentration invariance. However, at the level of individual boutons, we observed complex and non-monotonic concentration dependence responses. We next imaged bouton responses to odorant mixtures that contained between two and 12 components. When presented with complex mixtures of odorants, the activity of cortical projections was representationally distinct from component odorants. As a reference, we imaged the same panel of odorant mixtures in the olfactory epithelium, where we found a strong relationship between representational similarity and mixture complexity. Our current studies reveal how behaviorally relevant mixture information is inherited by the OB from the cortex.

S17-4 Beyond combinatorial code: initial stages of olfactory processing in Drosophila

Chih-Ying Su [1]

Shiuan-Tze Wu [1], Jen-Yung Chen [1], Vanessa Martin [1], Renny Ng [1], Ye Zhang [1], Dhruv Grover [2], Ralph Greenspan [1], Johnatan Aljadeff [1]

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A hallmark of complex sensory systems is the organization of neurons into functionally meaningful maps, which allow for comparison and contrast of parallel inputs via lateral inhibition. However, it is unclear whether such a functional map exists in olfaction. Here we address this question by determining the organizing principle underlying the stereotyped pairing of olfactory receptor neurons (ORNs) in *Drosophila* sensory hairs, wherein compartmentalized neurons inhibit each other via ephaptic coupling. Systematic behavioral assays reveal that most paired ORNs antagonistically regulate the same type of behavior. Such valence opponency is relevant in critical behavioral contexts including place preference, egg-laying, and courtship. Odor-mixture experiments show that ephaptic inhibition provides a peripheral means for evaluating and shaping countervailing cues relayed to higher brain centers. Furthermore, computational modeling suggests that this organization likely provides a novel mechanism for processing ratio information in odor mixtures. This olfactory valence map may have evolved to swiftly process ethologically meaningful odor blends without involving costly synaptic computation.

S17-5 Peripheral preprocessing in Drosophila facilitates odor classification

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The mammalian brain implements sophisticated sensory processing algorithms along multilayered ('deep') neural-networks. Strategies that insects use to meet similar computational demands, while relying on smaller nervous systems with shallow architectures, remain elusive. Using *Drosophila* as a model, we uncover the algorithmic role of odor preprocessing by a shallow network of compartmentalized olfactory receptor neurons. Each compartment operates as a ratiometric unit for specific odor-mixtures. This computation arises from a simple mechanism: electrical coupling between two differently-sized neurons. We demonstrate that downstream synaptic connectivity is shaped to optimally leverage amplification of a hedonic value signal in the periphery. Furthermore, peripheral preprocessing is shown to markedly improve novel odor classification in a higher brain center. Together, our work highlights a far-reaching functional role of the sensory periphery for downstream processing. By elucidating the implementation of powerful computations by a shallow network, we provide insights into general principles of efficient sensory processing algorithms.

S18-1 The role of floral humidity and hygrosensation in plant-pollinator interactions

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While floral scent and color are effective in attracting pollinators over larger distances, they become less informative once pollinators approach a flower (millimeters to centimeters). In the absence of additional cues such as contrasting nectar guides, scented pollen or nectar, the initial attraction may not translate into successful pollination. Even after the removal of nectar or pollen by earlier visitors, flowers can retain their scent, turgidity, and pigmentation for minutes to hours. Yet, it is commonly observed that pollinators sometimes reject certain flowers upon closer inspection, without landing. This suggests that pollinators rely on more reliable sources of information when making decisions in close proximity to flowers as they navigate a patch of flowering plants.

In present evidence from two distinct pollination systems: the nocturnal *Datura*-hawkmoth and the diurnal Squash Flower-Squash bees. Through these examples, I demonstrate that floral humidity can serve as an informative trait for pollinators over short distances. Our findings suggest that floral humidity of *Datura*

and Squash is not a consequence of nectar evaporation, rather we show that flowers actively generate humidity. Pollinators detect floral humidity using hygrosensing organs on their antennae, and our experiments reveal that occluding these organs diminishes their ability to distinguish between humid and ambient flowers. In summary, our research provides compelling evidence for the role of hygrosensation in guiding pollinators' flower choice.

S18-2 Up close and personal: Heat and humidity detectors for mosquito host-seeking and egg-laying behaviors.

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Gonzalo Budelli [2], Ruocong Tang [2], Elaine C. Chang [2], Rachel Busby [2], Shruti Shankar [2], Rachel Gerber [2], Chloe Greppi [2], Rebecca Albuquerque [2], Paul A. Garrity [2]

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Mosquito host-seeking relies on the detection of multiple host-associated sensory cues that exist at different spatial scales. At close range, mosquitoes detect increased temperature and humidity associated with the ~3cm “boundary layer” of warm, moist air surrounding the host, providing proximity information and influencing landing decisions. After blood feeding, humidity cues take on additional significance for mosquitoes seeking sources of water associated with oviposition (egg-laying) sites. Despite the importance for multiple steps in reproduction, relatively little is known about how mosquitoes sense heat and humidity. In *Drosophila*, proper thermosensation and hygrosensation (humidity detection) require members of the Ionotropic Receptor (IR) family. We recently demonstrated that heat seeking in the malaria vector *Anopheles gambiae* is driven by cooling-activated neurons requiring the IR subunit IR21a. We now show that *An. gambiae* and the arbovirus vector *Aedes aegypti* both require another IR, *Ir93a*, to maintain attraction to humans and feed efficiently on warmed blood. By genetically targeting *Ir93a*, we identify the mosquito hygrosensory system and show that *Ir93a* is required for hygrosensation as well as thermosensation (in neurons expressing Ir21a). These systems function in parallel, driving host proximity detection in response to the overlapping heat and humidity gradients humans produce. After blood feeding, gravid females require *Ir93a* to seek water for oviposition. Together, the data demonstrate the overall importance of short-range cue detection in complex mosquito behaviors and show that members of both major subfamilies of vector mosquitoes use overlapping molecular mechanisms to locate hosts and oviposition sites.

S18-3 Seeking amongst the clusters: a comparative transcriptomic study of the hygro- and thermosensory neurons

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Humidity and temperature are omnipresent environmental factors that influence fitness, reproductive behaviour and the geographic distribution of terrestrial animals.

Unfavourable combinations of temperature and humidity are increasing the danger of overheating or dehydration. At lower temperatures, poikilotherm animals show a higher sensitivity to humidity than

homeothermic animals. Due to their small size and therefore lower storage capacity for water, insects are especially at risk of desiccation making them an interesting model to study humidity and temperature sensing behaviour.

Furthermore, specific neurons for humidity sensing, the hygrosensory receptor neurons, have been described and studied in a wide variety of insects. While humidity and temperature are environmental cues, common disease-vectors like the yellow fever mosquito and the tsetse fly also rely on humidity and temperature cues to find their host and egg-laying sites.

In D. melanogaster and Aedes aegypti specific neurons for humidity (hygrosensory receptor neurons, HRNs) and temperature (thermosensory receptor neurons, TRNs) sensing are located on the antenna.

Hygrosensation is driven by a triad of neurons: a moist cell, a dry cell and a hygroool cell. Additionally, the antenna houses hot and cold cells.

By conducting a comparative comprehensive transcriptomic analysis of these neuronal groups, we aim to uncover the key features of the neuronal mechanisms mediating hygro- and thermosensation in the insect antenna. Our findings reveal distinct gene expression patterns associated with the five different types of neurons (moist, dry, hygrocool, hot and cold). There findings provide valuable insight into the neuronal mechanisms of humdity and temperature sensing behaviour.

S18-4 Acute water deprivation differentially modulates hygrosensory and visually-evoked behaviors across Drosophila species in tethered flight

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The generation of contextually appropriate behavior requires the integration of internal and external states. How then, do organisms encode dynamic representations of sensory information to drive flexible behavior? Due to their large surface area to volume ratio along with the energy demands of flight, dehydration is a constant threat to *Drosophila melanogaster*. We utilize a virtual reality flight simulator that permits tethered flying flies to rotate freely in response to controlled visual and olfactory/hygrosensory stimuli to ask whether flies alter the value of water cues upon dehydration in order to drive water seeking behaviors (hygrotaxis). We find that whereas hydrated flies assign a neutral value to a humid air plume in tethered flight, acutely dehydrated (3 hrs) flies assign a positive value to the same water cue in order to generate hygrotaxis behavior. Similar to reports investigating walking hygrotaxis, we find that Ir68a-expressing neurons in the third segment of the antenna are required for tethered flight hygrotaxis upon acute dehydration. In addition, we reveal a hydration-state dependent orientation towards horizontally polarized light, a visual indicator of water. Interestingly, hydration-state hygrotaxis and orientation towards a visual water cue vary across *Drosophila* desert species. Currently, we are investigating the neuromodulatory mechanisms that support state-dependent hygrotaxis behavior. This work lays a foundation for further exploration of how neural circuits integrate internal physiological states to generate flexible behavior and how these circuits may have differentially evolved to support *Drosophila's* survival within habitats with unique visual ecologies and environmental requirements.

S19-1 Why sugar tastes sweet: Fructose recognition by an insect taste receptor

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Joao Victor Gomes [1], Shivinder Singh-Bhagania [1], Matthew Cenci [1], Carlos Chacon [1], Manjodh Singh [1]

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Sweet taste receptors serve the essential role of identifying necessary nutrients, while also contributing to the pleasurable perception of consuming sweet foods. Here, I will focus on an exemplary gustatory receptor, Gr9 from the silk moth. While Gr9 is activated only by one type of sugar, D-fructose, we show that other sugars can bind, but fail to activate the receptor. We determined structures of Gr9 in multiple gating states—alone or bound to either D-fructose or the non-activating sugar L-sorbose—offering a unique entry point to investigate the biophysical basis for sweet taste. Our data demonstrate that the precise geometric arrangement of the ligand-binding pocket is not sufficient to adequately explain why only D-fructose can activate the channel. Instead, the chemical specificity of Gr9 is an emergent property arising from a combination of receptor-ligand interactions and allosteric coupling between the pocket and the ion channel pore. Activation efficacy, therefore, depends on residues that extend beyond the receptor-ligand interactions that occur in the binding pocket. By focusing on a chemoreceptor that is activated by a single ligand, we are able to derive a novel model for chemoreceptor function whereby coarse chemical tuning is governed by the size and chemical characteristics of the pocket, whereas fine-tuning of receptor activation is achieved through the selective engagement of an allosteric pathway that controls ion conduction. Our studies provide a foundation for understanding how evolutionary selection can tune the activity of receptors by acting beyond the ligand-binding pocket, and how related sugars may be discriminated.

S19-2 Ancient origins and functions of the insect odorant receptor superfamily

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Insect odorant receptors and gustatory receptors define a superfamily of seven transmembrane domain ion channels (7TMICs). Although 7TMICs were originally thought to be present only in invertebrates, over the past few years we have used sequence- and structure-based methods to identify evermore distant homologs across animals (including humans), plants, unicellular eukaryotes, archaea and bacteria. Our work reveals 7TMICs as a cryptic superfamily, originating close to the emergence of cellular life. I will describe this survey and what it tells us about the evolution of the protein family, as well as present our ongoing efforts to determine the expression and function of 7TMICs in diverse taxa.

S19-3 Exploring the activity and selectivity of olfactory receptors using chemoinformatics and molecular modeling

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Humans can distinguish thousands of odorant molecules through a repertoire of 390 odorant receptors (ORs), the largest subfamily within the group of G protein-coupled receptors (GPCRs). In this talk, I will discuss chemoinformatics analyses of a comprehensive library of biologically relevant odorants, such as the key food odorants [1]. The screening of ORs with this set of compounds revealed that some receptors are broadly tuned but very specific for certain chemotypes [2, 3]. Molecular modeling of the ligand-receptor interactions and molecular dynamics simulations shed light on the molecular mechanisms of OR selectivity and specificity.

(1) Dunkel et al. Nature's chemical signatures in human olfaction: A foodborne perspective for future biotechnology. Angew. Chem. Int. Ed. Engl. 2014, 53, 7124

(2) Nicoli et al. Modeling the orthosteric binding site of the G protein-coupled odorant receptor OR5K1. Journal of Chemical Information and Modeling, 2023, 63, 2014

(3) Haag, Di Pizio, Krautwurst. The key food odorant receptive range of broadly tuned receptor OR2W1. Food Chemistry, 2022, 375, 131680

S19-4 Querying the mechanism of human bitter taste receptor function by integrated experimental and computational tools

Lior Peri [1]

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There are 25 bitter taste receptors (TAS2Rs) in the human body, which are expressed both on the tongue and in other tissues. The large sequence variability of TAS2Rs, their extra-oral expression and varying ligand-binding capacity, make them an important target in physiology, protein chemistry and food science.

We were able to solve the cryo-EM structure of a human TAS2R, which shows significant differences from the only TAS2R structure available so far, and from the computational 3D models, including AlphaFold. We found major differences in the binding of ligands, and were able to support these findings using cell-based assays. The new structure and supporting mutagenesis constitute a breakthrough for the design of new ligands and for advancing the understanding of TAS2R physiological functions. Overall, the findings suggest important differences among TAS2R subtypes, and stress the importance of cryo-EM technique in chemosensory receptors research.

S19-5 Molecular basis of mammalian sweet taste detection

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Taste perception is one of the two strategies developed by our brain to decipher our chemical environment and give sense to sapid molecules. At the molecular level, the detection of sweetness is mediated by a single taste receptor (T1R2-T1R3), made of this assembly of 2 class C G protein-coupled receptor (GPCR) family. This heterodimeric receptor contains several binding sites and explains why it is associated with a large chemical space. To date, several hundred molecules have a sweet taste, and the search for an alternative to sugar is still on. In this context we will present how the methodologies and tools developed in our laboratories have allowed us to better understand the molecular basis of the sweet taste detection. We will show how integration of functional assays and computational approaches provides valuable insights on the structure-function relationships of the sweet taste receptor and help us to identify new sweet compounds.

S20-1 Investigating the central olfactory representations using a working memory paradigm

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The perception of olfactory stimuli is a multifaceted process incorporating the molecular identities of stimuli and the behavioural contexts. Research into early stages of olfactory processing, like in the olfactory bulb, reveals that perceptually similar stimuli elicit overlapping patterns of neuronal activity. However, distinguishing between closely related odours can improve with training, implying a dynamic interplay between peripheral and central processing mechanisms. It is hypothesised that this refined discrimination capability involves long-range inputs, which flexibly decorrelates similar odour representations through central neural networks. However, the mechanisms underlying these modulations remain poorly understood, necessitating further exploration into the central representations of olfactory information.

In this context, we delve into working memory paradigms, particularly the Delayed Non-Match to Sample (DNMS) tasks in head-fixed mice. By presenting two odours separated by a temporal interval within a trial and training animals to report whether the odours are identical, the paradigm offers a robust method for probing the perceptual distance and contextual modulation of olfactory representations. This talk will outline our recent endeavour to extend this paradigm to include a task-switching aspect to study higher representations of odour responses.

S20-2 The role of hippocampal interneurons in olfactory working-memory

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How does the brain keep track of events we need to remember as well as the intervals between them? When a series of sensory cues is experienced by mice, hippocampal spiking sequences encode these cues and link them in memory by tiling the time gaps between them. At each timepoint, these sequences retain the identity of the most recent cue and the time elapsed since its presentation. They, effectively multiplex working memory and timing information. But the role of inhibitory circuits in shaping these memory-encoding sequences remains unclear. I will present pioneering, longitudinal voltage imaging of cell-type-specific CA1 interneurons while mice perform an olfactory-cued memory task. Combined with 2-photon calcium imaging and electrophysiological data, these recordings demonstrate that CA1 interneurons increase the signal-to-noise ratio of hippocampal sequences during odor cues but not during time intervals between cues. Therefore, inhibition is crucial for efficient working memory encoding but less so for memory linking across time.

S20-3 Olfactory working memory dysfunction in an animal model of neuropsychiatric disorders

Alan Carleton [1]

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Working memory (WM) is the brain's essential mechanism for temporarily holding and manipulating information during cognitive tasks and communication. Information is thought to be maintained in a distributed network encompassing cortical and subcortical brain regions. However, a prominent WM model has also postulated the existence of a general memory store, though without evidence. If such a store were to exist, it would likely necessitate extensive reciprocal connections with various cortical areas to accommodate the diverse range of information that WM can retain. The claustrum (CLA), with its wide reciprocal connectivity with the neocortex, represents a potential candidate for such a role. In this study, we explored the potential involvement of the CLA in WM processes. We recorded CLA neurons in mice engaged in olfactory WM tasks. I will present evidence that the CLA can maintain information utilized in WM. Furthermore, since WM deficits are associated with various neurological and psychiatric conditions, such as ADHD and schizophrenia, I will also present evidence that the CLA is dysfunctional in an animal model of neuropsychiatric disorders

S20-4 Perceptual certainty quantified by olfactory matching in human subjects

Nixon Abraham [1],

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Matching of sensory stimuli involves different decision processes such as detection and discrimination, along with holding the perceived information. Accuracy and decision times, the interdependent readouts, can define the uncertainty involved in matching of sensory stimuli. To probe sensory and cognitive functions involving olfactory system in human subjects, we have developed a novel olfactory matching paradigm using an automated custom-built olfactory-action meter. With precise and consistent odor delivery and real-time data analysis, our system automates the entire process without any intervention by the experimenter, making it suitable as a diagnostic tool for quantifying olfactory and neurocognitive fitness [1, 2]. In around 400 healthy human subjects, with mean detection accuracy of 90%, we observed significantly better olfactory matching performance for simple monomolecular odors, in comparison to complex binary odor mixtures. Odor matching accuracy declined significantly with the increase in odor complexity. Olfactory matching was more rapid when subjects made correct versus incorrect decisions, indicating perceptual certainty. Subjects also took longer matching time for complex odors compared to simple odor stimuli. Thus, olfactory matching that provides a combined readout of sensory and cognitive fitness, establishes a direct link between the performance accuracy and the certainty of decisions.

A. S. Bhattacharjee, S. V. Joshi, S. Naik, S. Sangle, N. M. Abraham, Quantitative assessment of olfactory dysfunction accurately detects asymptomatic COVID-19 carriers. *Eclinicalmedicine* **28**, 100575 (2020).

R. Bhowmik *et al.*, Persistent olfactory learning deficits during and post-COVID-19 infection. *Curr Res Neurobiol* **4**, 100081 (2023).

S21-1 Mapping Neural Circuits of State-dependent Behavior in the Fly

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Perceptions and decisions depend on sensory impressions, but also on past experiences and the present internal state of an animal. Behavior is therefore very adaptive and flexible. For instance, a hungry animal

perceives the smell and taste of food as much more positive than a fed animal. At the same time, it is willing to take a high risk and invest time and energy in order to find food. Which signals and neural networks allow the communication between brain and body? And how do they modulate behavior and decision-making in the best interest of the organism?

We aim at answering these questions at three levels: (1) behavior, (2) neural networks, and (3) genes. To this end, we are using *Drosophila* genetics in combination with modern techniques including high resolution behavioral analysis, optogenetics, and in vivo whole brain and multiphoton microscopy. In particular, we focus on how the brain dynamically translates chemosensory information, i.e. odors and tastes, into state- and experience-dependent perceptions and ultimately into behavior. In my talk, I will discuss two recent examples of our ongoing work.

S21-2 Information theory predictions for the integration of modulatory and sensory inputs

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In this presentation, I will describe theoretical predictions for how modulatory circuits should be structured to maximize the transfer of sensory information in the presence of modulation. One of the main predictions in that modulatory signals should be delivered to sensory processing neurons via inhibitory neurons. The inhibitory neurons should optimally target not all of the sensory neurons but a subset. I will conclude with the discussion of these results with implications for olfactory coding.

S21-3 Integration of olfactory and limbic information in zebrafish brain

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The primary focus of my lab is to understand how sensory information interacts with the internally generated neural dynamics within the forebrain, representing animals' behavioral states. To achieve this, we measure neural activity and connectivity from thousands of individual neurons in the adult and juvenile zebrafish brain and analyze these neural datasets using applied mathematics. Our research has revealed that the habenula, a forebrain region important for adaptive behaviors, serves as a central hub that integrates various sensory inputs, such as smell, vision, and sound, with the internal activity of the limbic networks in the forebrain. Our results have shown that multi-sensory signals can specifically increase and decrease the activity of distinct subregions within the habenula and the telencephalon. We observed that sensory-evoked inhibition within the habenula is mediated by type-3 metabotropic glutamate receptors. Pharmacological/genetic perturbation of these receptors alters sensory representations and functional connectivity in the habenula, perturbing adaptive behaviors. Currently, we are using spatial transcriptomics to identify distinct neural populations and regions within the zebrafish forebrain and to relate our findings to other vertebrates.

S21-4 Olfactory control of limbic development

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The interplay between olfaction and higher cognitive processing has been documented in the adult brain, yet its development is poorly understood. In mice, shortly after birth, endogenous and stimulus-evoked activity in the olfactory bulb (OB) boosts the oscillatory entrainment of downstream lateral entorhinal cortex (LEC) and hippocampus (HP). However, it is unclear whether early OB activity has a long-lasting impact on entorhinal-hippocampal function and cognitive processing. To fill this knowledge gap, we combine multi-site recordings with opto- and chemogenetics *in vivo* as well as behavioral testing. The investigations show that activation of OB during defined time window(s) of neonatal development is critical for the adult function of entorhinal-hippocampal circuits and cognitive performance in working memory and decision making tasks. The results mechanistically elucidate how cognitive performance relies on early sensory imprinting.

S21-5 The noise within the human olfactory machine

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The wide world of odors that we regularly encounter is intrinsically noisy, comprised of complex volatile mixtures that are spatiotemporally dynamic and subjected to uncertainty, both external and internal. Here, we have developed a conceptual framework to account for the noise that arises from different sources of variability. Our main hypothesis is that olfactory noise is regulated in a manner consistent with predictive coding, such that sensory information is weighted according to its precision. Within this framework, precise information is amplified, and noisy information is suppressed. At the neural level, predictive coding allows for both amplification and suppression within neuromodulatory areas in the human basal forebrain and brainstem that disinhibit (amplify) olfactory centers carrying precise information and inhibit (suppress) olfactory areas carrying noisy information. We find that by manipulating the “noisiness” of the odor identities along a continuum from 100% pine to 100% banana, subjects down-weighted noisy odor information when forming the shape-odor associations. Additional preliminary analyses suggest that BOLD activity in the brainstem and basal forebrain are parametrically modulated by the noisiness of the olfactory information. Overall, these preliminary results intriguingly suggest that neuromodulation of the olfactory system amplifies precise information and suppresses noisy information in the service of robust olfactory behavior.

S22-1 Effect of exposure to positive emotional body odors on creativity

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Human beings can communicate their emotions to others via volatile emissions from their bodies. There is now solid evidence of the chemical communication of fear, stress and anxiety between humans. Positive emotions however, have been more rarely studied. Here we will present a series of studies aiming at testing whether positive emotions can be communicated through body odor, from (A) a donor in whom we induce a positive vs. a neutral emotional state, to (B) a receiver exposed to donor’s axillary odor samples. Using videos to induce emotions in donors, we found a decreased heart rate and increased performances during creativity tasks in receivers, in response to the positive body odors compared to the neutral ones. These results suggest that the donor’s positive emotional state was

transferred to the receivers (emotional contagion). When using virtual reality as a more immersive induction method, the conclusions were more mitigated, although similar patterns of results were found. In a third experiment, we investigated a few factors that may modulate the chemical communication of emotions (type and duration of the relationship between donor and receiver, donor's and receiver's sex, personality traits). How the addition of perfume interacts with this chemosensory communication was also questioned in this series of experiments. Overall, it seems that chemical communication of positive emotions exists in humans; however, its intra- and interindividual variations need to be better understood.

S22-2 Subjective perception of positive and negative emotional body odors and common odors in autism-spectrum disorders

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Autism-spectrum disorders (ASD) are characterized by deficits in social domains, associated with abnormal socio-emotional perception. Although olfaction provides access to socio-emotional cues, little is known about the perception of emotional odors considering their social meaning in ASD. With this experiment, we aimed to explore the subjective perception of emotional body odors (BOs) versus non-social, common odors (COs) in ASD patients. Eleven ASD and 49 typically developed (TD) adults were asked to smell negative, positive, and neutral BOs and COs, and to rate each odor on perceived pleasantness, intensity, familiarity and arousal. Analyses were performed with linear mixed-effect models with fixed factors (group x odor type x valence) and covariates (e.g. age; intensity for arousal/familiarity; familiarity for pleasantness). Odors were perceived as significantly more intense ($p = .044$) and pleasant ($p < .001$) in ASD than TD. Distinct response patterns were found in ASD and TD. First, positive BOs and COs were similarly arousing and pleasant in ASD ($p > .05$), but not in TD ($p < .001$). Second, positive and neutral COs were equally arousing, familiar and pleasant in ASD ($p > .05$), but not in TD ($p <.001$). No differences were observed between BOs in ASD and TD ($p > .05$). In conclusion, ASD is associated with abnormal subjective responses to emotional odors, which could contribute to the social communication difficulties characterizing ASD. Since emotional BOs elicit psychological responses in others, analyses on subjective and automatic responses will allow a better understanding of the role of olfaction in ASD.

S22-3 Chemosensory happiness strengthens brain activity and prosocial behaviour

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Human brain and behaviour are affected by conspecific chemosensory cues related to negative affect. The current studies examine the effects of happiness-related sweat by means of chemosensory event-related potentials and prosocial behaviour.

Axillary sweat was sampled from 25 women while awaiting the arrival of loved ones after a period of separation (happiness condition), and during ergometer training (sport condition). Self-reported happiness

was higher in the happiness than in the sport condition ($p < .001$). In study 1, sweat samples and sweatless cotton were presented to 26 men and 27 women via a constant-flow olfactometer (100 ml/s, 0.5 s, ISI: 18.5-22.5 s) during EEG-recording (61 electrodes), and interpeak amplitudes (N1-P2, N1-P3) in reference to cotton were analysed. In study 2, 81 women (27 per condition) were exposed to one of the sweat samples or cotton via paper fleece masks, while witnessing an individual struggling with a fiddly task. Their behaviour was recorded and coded blindly for prosociality.

In study 1, N1-P3 interpeak amplitudes were larger in response to happiness-related- compared to sport sweat ($p = .033$, $\eta_p^2 = 0.086$), indicating enhanced evaluative neural processing. In study 2, the proportion of women behaving prosocially was higher in the happiness (67%) compared to the cotton condition (41%, $p = .050$, $\varphi = 0.26$).

The current studies show that the human brain processes happiness-related sweat as a highly relevant social cue, and that exposure to this cue facilitates prosocial behaviour. The latter indicates emotional contagion, since happy individuals are generally inclined towards prosociality

S22-4 Empathy related body odours shape social perception

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Previous research suggests that in humans, social traits can be transmitted chemosensorily. The present study investigates whether body odours from individuals with either strong or weak empathic perspective-taking abilities affect face perception.

Axillary sweat was collected from 32 (16 female) healthy donors during their night's sleep. Donors and perceivers were categorized as either high or low in empathic perspective-taking by median split. In study I, 87 participants had to recognize an individual's gender based on ambiguous eye regions, while gender-congruent, gender-incongruent body odours, and cotton control odour were presented via face masks (43 ml/s). In study II, the recognition of happy and sad facial expressions was assessed via eye-tracking in 76 participants. Simultaneously, empathy-related body odours and cotton odour were presented.

In study I, gender-congruent body odours improved women`s ability to infer the correct gender from eye regions (compared to cotton odour, $p = 0.022$). In study II, highly empathic participants needed less time to evaluate emotion-relevant features in happy faces when perceiving body odours of highly empathic individuals in comparison to body odours of low empathic individuals (first fixation duration, $p = 0.025$). Similarly, in highly empathic women, the efficiency to scan sad facial expressions was increased in the context of body odours of highly empathic individuals (first fixation duration, $p = 0.047$). The initial speed of emotional face recognition (entry time) was not affected by the body odour context. The results indicate that gender- and empathy-related body odours facilitate corresponding aspects of face perception.

S23-1 Predicting intensity interactions in odor mixtures

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Most odors encountered in daily life are complex mixtures where molecules interact with each other. Multiple models exist to predict the odor intensity of a mixture from the intensity of its components; however, these interaction models have not been compared systematically and are not based on biophysical interactions. In this study, 15 human panelists rated the intensity of binary (N = 216) and complex (N = 44) mixtures where each component was presented at varying concentrations. Common models, such as euclidean addition and strongest-component, consistently overestimated mixture intensity, as most mixtures were less intense than the strongest component. Based on previous reports showing predictions of neuronal responses to odor mixtures are improved by adding information about each component's concentration-intensity function, we collected intensities at a range of concentrations for several odorants spanning chemical space (N = 62) to successfully train a machine-learning algorithm to estimate the concentration-intensity function for any odorant at any concentration ($r(928) = .80$, $p < 0.001$). A primacy model which weights odor component contributions by their relative affinities rather than their currently perceived intensities accurately estimates the intensity of 2, 3, 5, and 10-component mixtures ($r(258) = 0.84$, $p < 0.001$). Our results demonstrate the ability to predict the full concentration-intensity function for odorants in odor mixtures and use this information to produce better estimates of its odor intensity than previous models. This model ensemble offers a reliable method to predict odor intensity of naturalistic mixtures, essential for understanding and replicating complex scent profiles.

S23-2 Untangling relationships between the chemical tuning and timing of odor representations in the mouse olfactory bulb

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In the mammalian olfactory system, odorants evoke distinct temporal patterns of activity linked to inhalation, yet the determinants and importance of these patterns remain unclear. To test hypotheses of how temporal patterns encode odor information, we used two-photon imaging in awake mice expressing genetically encoded calcium or glutamate reporters in olfactory sensory neurons (OSNs) or mitral/tufted (MT) cells, and built on recent work establishing 'primary' glomeruli for particular odorants. Increasing odorant concentration recruited activation in additional glomeruli, but initial response latencies and subsequent inhalation-linked dynamics only sometimes correlated with relative sensitivity. However, dynamics were well predicted by a combination of odorant chemical features and glomerular location. In particular, glomeruli in the class I OSN domain showed faster responses to acids than to their corresponding esters and aldehydes, while ester-sensitive glomeruli in the class II domain were less-sensitive but responded more rapidly. These relationships persisted across concentration and were also apparent in MT glomerular signals and MT somata, suggesting that delayed activation of OSN input is not filtered by OB circuits but instead drives delayed OB output. Overall, results were best explained by a model involving rapid (sub-sniff) conversion of inhaled odorants by enzymes in the nasal epithelium, in which enzymatically-generated 'secondary' odorants activate their cognate receptors with a slight delay relative to the inhaled odorant, and a loss of respiratory coupling. In this model, relative latencies and coherence to respiration serve to disambiguate inhaled odorants from those generated internally, suggesting a novel role for temporal response patterns in odor coding.

S23-3 Revealing The Neural Encoding Of Perceived Odor Intensity

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Olfaction is a cardinal sense that guides most behaviors in several animal species. Behaviors such as foraging, navigation, and mate selection all heavily rely on the ability to follow the intensity gradients of odors. Understanding how the brain encodes odor intensity is vital for gaining insight into how the brain processes odor-guided behaviors. Several studies have shown that changes in odorant concentration are correlated with changes in neurons firing rate, temporal shifts in responses relative to inhalation, or overall synchrony of neural responses. However, odorant concentrations are inappropriate proxies for perceived intensity: at similar concentrations some odors evoke strong sensations, while others are merely perceivable. Therefore, it remains unclear which neural phenomena underlie the perception of odor intensity.

One major challenge to study the neural encoding of intensity is obtaining perceptual reports and neural recordings from the same animal model. Here, we leveraged a behavioral paradigm in the mouse that allows to measure which concentrations of an odor pair produce intensity-matched odor perception. We selected a set of three odors and computed the intensity-matched concentrations for each odor pair. We found that the derived intensity-matches were invariant to the selected odor pair ($p<0.05$). We repeated this measure at three different concentration ranges, with errors as low as 1 ppm (standard deviation ranged from 0.15 pm to 10.42 ppm). We propose that by pairing neural recordings and the intensity-matching paradigm in the mouse we can study the encoding of odor intensity in a mouse model in an unprecedented fashion.

S23-4 Neural oscillatory coding of perceived odor intensity in human olfactory cortex

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Perceived intensity of odors is an important component of olfactory processing. However, most studies use odor concentration as a proxy for perceived intensity. While odor concentration is related to perceived intensity, there is not always a direct correspondence between odor concentration and perceived

intensity, as different odors smell stronger than others. In order to characterize representations of perceived odor intensity in humans, we collected perceived intensity ratings on each presentation of different odors of different concentrations during direct recordings of local field potentials (LFPs) in human piriform cortex. Neural correlates of odor concentration in rodents—including spike rates and latencies, and ensemble synchrony—have been shown in the olfactory bulb and piriform cortex. By analyzing human LFPs in response to odors of different perceived intensities, with perceptual ratings that are only available in human participants, we will work towards merging neural correlates of odor concentration in rodents (*e.g.,* ensemble synchrony, latency) with those in humans. In a 3x3 experimental design, participants (n = 5) smelled 3 odorants (benzaldehyde, 2-heptanone, and diethylprazine) at 3 concentrations (low, medium, and high). Odorants at concentrations previously matched for intensity were delivered through a controlled system to ensure the concentration of each stimulus was consistent across trials. Trials were sorted by perceived odor intensity ratings collapsed across odor identities and responses of human piriform LFPs were analyzed. Preliminary data suggest differences between neural correlates of perceived intensity and those of odor concentration, including amplitude and latency effects in distinct frequency bands of piriform neural oscillations.

S24-1 Sensory Pathways of the Mammalian Airways

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The respiratory tract is an essential barrier tissue that is exposed to inhaled insults from the environment throughout life. Airway neurons employ a rich suite of mechanisms to encode many different sensory cues, filtering and organizing this information into circuits that signal to the brain to control life-preserving reflexes like breathing, alter behavior and cognition, and regulate tissue health. Despite their importance for survival, these pathways remain poorly understood at the cellular and molecular level. In prior work, we used single cell RNA-sequencing to chart the diversity of airway-innervating sensory neurons in the mouse vagus nerve. By curating a library of Cre driver mice, we used genetically-guided tracing, ablations and optogenetics to pinpoint specific throat-innervating neurons that guard the airways against inhaled water and acid, and separately against respiratory influenza infection. Overall, our work provides mechanistic insights into the neural basis of airway defense, and offers a generalizable roadmap for understanding circuits responsible for internal organ sensation.

S24-2 Tracheal tuft cells exert antimicrobial host defense via communication to sensory nerves

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Recognition of invading pathogens is a prerequisite for initiation of the host's first-line protective immune responses and their subsequent elimination. The generally accepted view is that the host innate immune system recognizes invading pathogens using classical pattern recognition receptors. However, bacterial products such as quorum sensing molecules (QSM) act as agonists for non-immune receptors like canonical bitter taste receptors (T2R). Several groups including our own identified T2R and components of the canonical taste transduction cascade in a specialized epithelial cell type (termed solitary chemosensory, brush or tuft cells) in a variety of locations beyond the tongue, from the airway and gastrointestinal epithelia to the urethra.

An appealing concept has emerged that tuft cells (TCs) in the lower airways serve as sentinels to protect against the further ingression of potentially harmful bacterial substances into the lung. Application of bitter

substances and bacterial products to the tracheal mucosa resulted in the release of acetylcholine (ACh) from TCs followed by depression of respiration. Recently, we reported that TCs stimulated adjacent sensory nerve endings in the trachea to evoke protective neurogenic inflammation responses involving the release the neuropeptides CGRP and Substance P, both consequently triggering plasma extravasation, neutrophil recruitment and diapedesis. Protective responses were abolished in mice either lacking TCs or their signaling components, sensory innervation and after inhibition of peptidergic and cholinergic signaling. Mice deficient for TC signaling are more susceptible to *P. aeruginosa* infections than wildtype mice and have poorer outcome. Taken together, TCs are essential gatekeepers of pulmonary health.

S24-3 Epithelial chemosensation of the larynx that triggers airway protective reflexes

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Neural reflexes to chemicals in the throat protect the lungs from aspiration and infection, and are thus crucial for survival. Dysfunction in these reflexes represents an unmet medical need. Despite their importance, the molecular and cellular mechanisms underlying these reflexes remain largely unclear. Meanwhile, the recent discovery of channel synapses between epithelial chemosensory cells and afferent nerves, characterized by synaptic vesicle-independent, CALHM1/3 channel-mediated neurotransmitter (ATP) release, has revealed a previously unknown mechanism of body-brain interactions through these synapses. In this study using mice, by combining a whole-body survey for channel synapses with single-cell transcriptome analyses, we discovered subclasses of the *Pou2f3*$^+$ chemosensory epithelial cell family in the throat that communicate with vagal neurons via the channel synapse. These epithelial cells express Tas2Rs, a set of G protein-coupled receptors for diverse noxious chemicals, and trigger airway protective reflexes in response to luminal Tas2R ligands. Targeted optogenetic stimulation of these *Pou2f3*$^+$ chemosensory cells also initiated these reflexes. Furthermore, upon stimulation, these cells release ATP, and the associated reflexes were abolished by *Calhm3* knockout and pharmacological inhibition of ATP receptors on vagal neurons, demonstrating the involvement of the purinergic channel synapse for neurotransmission. Together, these findings identify *Pou2f3*$^+$ epithelial cells with channel synapses as previously unrecognized chemosensory end organs for airway protective reflexes and their molecular signaling pathways, advancing our understanding of airway defense mechanisms and offering distinct therapeutic targets.

S24-4 The nasal solitary chemosensory cell signaling pathway triggers mouse avoidance behavior to inhaled nebulized irritants

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The nasal epithelium houses a population of solitary chemosensory cells (SCCs). SCCs express bitter taste receptors and taste transduction signaling components and are innervated by peptidergic trigeminal polymodal nociceptive nerve fibers. Thus, nasal SCCs respond to bitter compounds, including bacterial metabolites, and these reactions evoke protective respiratory reflexes and innate immune and inflammatory responses. We tested whether SCCs are implicated in aversive behavior to specific inhaled nebulized irritants using a custom-built dual-chamber forced-choice device. The behavior of mice was recorded and analyzed for the time spent in each chamber. Wild-type (WT) mice exhibited an aversion to 10 mM denatonium benzoate (Den) or cycloheximide and spent more time in the control (saline) chamber. The SCC-pathway knockout (KO) mice did not exhibit such an aversion response. The bitter

avoidance behavior of WT mice was positively correlated with the concentration increase of Den and the number of exposures. Bitter-ageusic P2X2/3 double KO mice similarly showed an avoidance response to nebulized Den, excluding the taste system's involvement and pointing to an SCC-mediated major contributor to the aversive response. Interestingly, SCC-pathway KO mice showed an attraction to higher Den concentrations; however, chemical ablation of the olfactory epithelium eliminated this attraction attributed to the smell of Den. These results demonstrate that activation of SCCs leads to a rapid aversive response to certain classes of irritants with olfaction, but not gustation, contributing to the avoidance behavior during subsequent irritant exposures. This SCC-mediated avoidance behavior represents an important defense mechanism against the inhalation of noxious chemicals.

S25-1 From sugars to fat -how starvation switch taste preference in Drosophila

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Food generalists, such as Drosophila Melanogaster, adapt their preferences based on food availability. Well-fed Drosophila prefer sugar, but starvation shifts their preference to prioritize calories, leading to increased intake of low-sweet-caloric foods. Our previous research shows that excess sugar intake triggers Hedgehog secretion from the gut, suppressing sweet taste perception. Here, we will present our latest research that demonstrate how flies leverage this mechanism to develop new food preferences during starvation. Prior studies shows that starvation increases sugar perception and at the same time induces caloric food preference. Using genetics, we discover that in response to starvation the gut secretes Hedgehog to the hemolymph and that this signal suppresses sugar taste perception and drive caloric food choice. Hedgehog overexpression also induces caloric food preference even in non-starved flies, highlighting its role as both necessary and sufficient for the preference switching. It is noteworthy that other starvation signals simultaneously upregulate sweetness, potentially at the synapse, masking the suppression and possibly altering the signal transmitted to the brain. By implementing the filtering process within taste neurons rather than in the brain, the associated cost of modulating feeding decisions is likely reduced. Last, our findings reveal that starvation trigger through Hedgehog a preference for fatty foods, similar to the effect observed when sugar is overconsumed. This suggests that the same mechanism is employed whether sugar is lacking or in excess, broadening the food choices made by Drosophila in both scenarios.

S25-2 Females smell differently: characteristics and significance of the most common olfactory sensilla of female silkmoths

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In the silkmoth *Bombyx mori*, the role of male sensilla trichodea in pheromone detection is well established. Here we study the corresponding female sensilla, which contain two olfactory sensory neurons (OSNs) and come in two lengths, each representing a single physiological type. Only OSNs in medium trichoids respond to the scent of mulberry, the silkworm's exclusive host plant, and are more sensitive in mated females, suggesting a role in oviposition. In long trichoids, one OSN is tuned to (+)-linalool and the other to benzaldehyde and isovaleric acid, both odors emitted by silkworm feces. While

the significance of (+)-linalool detection remains unclear, isovaleric acid repels mated females and may therefore play a role in avoiding crowded oviposition sites. When we examined the underlying molecular components of neurons in female trichoids, we found non-canonical co-expression of *Ir8a*, the co-receptor for acid responses, and *ORco*, the co-receptor of odorant receptors, in long trichoids, and the unexpected expression of a specific odorant receptor in both trichoid sensillum types. In addition to elucidating the function of female trichoids, our results suggest that some accepted organizational principles of the insect olfactory system may not apply to the predominant sensilla on the antenna of female *B. mori*.

S25-3 Investigating the taste space of mosquitoes – adenine nucleotides revisited

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The ultimate decision of a mosquito to accept or reject a resource is a matter of taste. We have a rudimentary knowledge of the peripheral taste system in mosquitoes, and a basic panel of tastants mosquitoes detect, which has been historically based on the anthropomorphic classification of the modalities sweet, bitter, salty and sour. This classification can be immediately questioned, as previous studies have clearly shown that haematophagous mosquitoes detect adenylated nucleotides, which fit into none of these modalities. Recent investigations into insect taste, predominantly in fruit flies and bees, is constructing a model of the insect taste system fundamentally described by the valence and modulation of the behavioural phenotype (acceptance versus rejection), together with its neural and genetic correlates. In a model such as this, it is more important than ever to accurately describe the 'taste space' of the mosquito, that is to identify the tastants detected by the mosquito in its natural environment and describe the mechanisms by which these signals are received and processed. This presentation will revisit the phagostimulatory effects of adenine nucleotides placing established research in a state-of-the-art context. No-choice feeding assays were used to describe adenine nucleotide detection (specificity and sensitivity), and the effects of imbibed toxins on this detection pathway. The adenine nucleotide taste space of mosquitoes, and its regulation, exhibits both similarities with and differences from the other haematophagic arthropods, and therefore requires further investigation, from both fundamental and applied perspectives.

S25-4 Single-nuclei RNA sequencing suggests that moth pheromone receptor neurons express more than one odorant receptor

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In moths, mate finding relies on female-emitted sex pheromones that the males decipher within a complex odorant background. Such a background, especially plant-emitted volatiles, has been shown to interfere with pheromone detection. At the neuronal level, electrophysiological studies on diverse moth species revealed that the pheromone-evoked firing activity of pheromone sensitive neurons was modified when plant volatiles were co-applied. In the Noctuid moth *Agrotis ipsilon*, previous studies have shown that plant volatiles activate pheromone sensitive neurons tuned to the major pheromone component (*Z*)7-12:Ac. A possible explanation is that the pheromone receptor protein expressed in (*Z*)7-12:Ac-sensitive

neurons recognizes both pheromone and plant volatiles. An alternative hypothesis is that (*Z*)7-12:Ac-sensitive neurons express more than one odorant receptor.

To test these hypotheses, we first worked at the receptor level. We revealed that the *A. ipsilon* pheromone receptor protein AipsOR3, tuned to (*Z*)7-12:Ac, did not respond to the tested plant volatiles, when expressed in *Drosophila* empty t1 sensillum neurons and in *Xenopus* oocytes. As these results suggest that the neuron responses to these compounds are due to the presence of another odorant receptor, we next conducted single nuclei RNA sequencing on *A. ipsilon* antennae. We revealed that (*Z*)7-12:Ac-sensitive neurons express additional receptors.

Our results are in line with previous reports that suggested expression of at least 2 odorant receptors in some insect olfactory neurons. However, our study is the first to report expression of more than one odorant receptor in neurons tuned to the major pheromone component in moths.

S25-5 An essential role for depolarization block in odor discrimination

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With a limited set of odorant receptors, olfactory systems identify and discriminate between vast arrays of odors across a wide range of concentrations. The combinatorial receptor code theory proposes that each odor is represented by a unique activation pattern of olfactory sensory neurons (OSNs). We recently discovered that OSNs enter a silent state due to depolarization block about three orders of magnitude above their detection threshold (Tadres et al., 2022). We hypothesized that this silent state preserves the sparseness of the combinatorial code at high concentrations, thereby facilitating discrimination between odors that elicit similar patterns of OSN activity.

To test this hypothesis, we used a classical (Pavlovian) conditioning paradigm to investigate the ability of *Drosophila*larvae with a minimal olfactory system reduced to two functional OSNs to discriminate between pairs of odors. By combining electrophysiological recordings and a detailed biophysical model of the OSN response dynamics, we characterized the neuronal activity of each OSN during olfactory choice behavior in freely-moving larvae. Our results establish that larvae can discriminate between odors when the concentration of one odor leads to depolarization block in one of the two functional OSNs. In larvae with a fully functional olfactory system, we confirm that depolarization block in a single OSN can condition discrimination between two odors.

Altogether, our results highlight that depolarization is not a ‘bug’ but a ‘feature’ of the olfactory code, which might explain why humans perceive odors differently at high versus low concentrations.

S25-6 A chemosensory mechanism of temporal niche partitioning

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Animals have evolved an extraordinary diversity of sensory mechanisms and behaviors to prosper in the environment. However, the molecular and neuronal processes shaping behavioral evolution and niche adaptation remain poorly understood. *Drosophila sechellia* is a powerful genetic model for dissecting the evolutionary and mechanistic basis of niche adaptation, as it is closely-related to the cosmopolitan generalist *D. melanogaster*, but is a specialist, feeding and reproducing exclusively on *Morinda citrifolia* "noni" fruit, which is toxic for other drosophilids and insects. In nature, host fruits change substantially over time - during ripening and rotting - and we have examined the behavioral responses of *D. sechellia* towards different stages of noni. We found that *D. sechellia* exhibits a narrow time window of preference for the ripe stage of noni. This stage, but not earlier or later stages, is highly toxic for *D. sechellia*'s competitor, *D. simulans* and its predator *Leptopilina boulardi*. Through an analysis of volatiles of different noni's ripening stages together with comparative single-cell antennal transcriptomic datasets in drosophilids, we identified potential olfactory pathways underlying this preference. Notably, we found that *D. sechellia*, but not other drosophilids, express the receptor Or45a in antennae, where it mediates detection of *2*-nonanone, a volatile abundant in ripe noni. Together, our findings suggest that the olfactory system of *D. sechellia* has evolved to exploit a very narrow time window of its host and that this adaptation represents a potent mechanism by which this species enhances its fitness through avoidance of competition and predation.

S26-1 Molecularly distinct wiring specificity in the mouse olfactory bulb

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The main olfactory bulb (OB) is the primary site of olfactory information processing between the sensory periphery and higher cortical regions. OB projection neurons, mitral and tufted cells, exhibit distinct functional properties in encoding odorant features, such as odor intensity. Such computations are thought to be mediated by the periglomerular cells (PGCs). However, it is unknown whether and how projection neurons are differentially modulated by subgroups of interneurons, such as those expressing different molecular markers. Consequently, the functional roles of the PGC subtypes remain unknown due to a lack of knowledge about the synaptic connectivity with OB projection neurons.

We hypothesized that PGC subtypes exhibit connectivity differences and therefore, have functionally-distinct roles in odor processing. Through a correlative electron microscopy (EM) reconstruction of a genetically-identified glomerulus, we have investigated the differences in synaptic connectivity between neurochemically-distinct PGC subtypes and projection neurons. We developed a permeabilization-free immunohistochemistry protocol compatible with serial block-face EM, which permits deep antibody penetration and preserves ultrastructure. This approach allows us to directly correlate the morphological and physiological properties of neurons through a dense reconstruction of synaptic connectivity. To investigate the PGC-subtype specific involvement in OB computations, we generated network-level computational models using the measured synaptic connectivity. This model predicts the mechanism underlying odor concentration encoding by mitral cells and demonstrates how structure underlies function. The volumetric EM reconstruction and anatomically-based computational modeling suggest that the wiring specificity between PGC subtypes and the mitral and tufted cells underlies OB computations.

S26-2 An olfactory social language in the naked mole-rat?

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Olfaction plays a crucial role in the survival and social behavior of many species. One exceptionally social mammal is the naked mole-rat, which lives in large colonies led by one dominant female, known as the queen. She is the only breeding female capable of lactating in the colony. We hypothesized that despite its subterranean habitat, the naked mole-rat exhibits a keen olfactory sense which might foster social bonds within the colony and aid in identifying colony members, intruders, and potential threats. However, our understanding of the specific chemical cues governing their social and maternal behaviors remains limited. Here, we examined the chemical signals involved in the social communication of naked mole-rats and the underlying neurobiological substrates. Our chemical analyses of odor profiles from various members have unveiled the presence of a previously unknown queen-specific compound, which has also previously been detected in human breast odors. Electrophysiological recordings indicated that the queen odor is detected by the activation of olfactory sensory neurons in the main olfactory epithelium. Behavioral experiments indicatedthat females may exhibit attraction to this compound, while males display aversion. Furthermore, our findings reveal that different species of mole-rats exhibit distinct chemical profiles, with the naked mole-rat “queen” odor detected in social species, but absent in solitary species, highlighting the significance of this compound in social communication among African mole-rats. Our findings illuminate the role of olfactory communication in the social dynamics of naked mole-rats, providing valuable insights into the unique social structure and ecological niche of naked mole-rats.

S26-3 A 3D molecular map of the mouse olfactory bulb generated with spatial transcriptomics

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The molecular and cellular structure of the brain provides critical information for understanding neural circuit functions. However, to date, no comprehensive 3D molecular maps of mammalian brain regions have been generated. The olfactory bulb (OB) is an excellent model to study the relationship between structure and function, as the distinct organization of glomeruli determines the transfer of odor information from the periphery to the olfactory cortex. Here, we used sequencing-based spatial transcriptomics to generate a comprehensive, 3D molecular map of the entire mouse OB. We performed 10X Visium Spatial Gene Expression analysis on 200 consecutive 10µm sections of OB tissue, and we integrated gene expression with precise 3D morphological alignment. We built a probabilistic model of odorant receptor gene expression and developed a dual autoencoder model of relative geometry to provide a quantitative measure of the positions of genetically identified glomeruli. We confidently defined the positions of 968 glomeruli, determined axes of inter- and intra-bulb symmetry, and identified ventromedial and dorsolateral domains based on the positions of sister glomeruli. Finally, by integrating glomerular organization with whole-transcriptome gene expression, we provide a comprehensive analysis of OB domain structure. Our

work provides the foundation for integrating molecular-structural information with functional studies to better understand mechanisms for odor processing in the mammalian brain.

S26-4 Trans-generational inheritance of olfactory rule learning in rodents

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Learning of a particularly complex olfactory-discrimination (OD) training paradigm results in acquisition of rule learning, manifested in a dramatic enhancement of learning ability. Using slice electrophysiology, dendritic calcium imaging and pharmacology techniques, we show that rule learning results in elevated intrinsic excitability of piriform cortex (PCx) pyramidal neurons and enhanced back-propagation of action potentials along the dendrites. The increase in back-propagation is due to experience-dependent down regulation of Kv4.2 channels from the dendrites of PCx pyramidal neurons. Furthermore, we show that naïve, untrained offspring (F1) of trained parents (F0) who mastered the rule-learning-based task were much better learners than those whose parents were not similarly trained. Changes in the biophysical properties of PCx pyramidal pyramidal neurons, which are physiological markers of rule learning acquisition, accompanied this superb learning ability. While genetic transfer of specific memories based on sensory experience has been shown before, the inheritance of cellular changes that result in a global learning state is a novel phenomenon, shown here for the first time.

S26-5 Investigating the molecular mechanisms of neural self-avoidance in the mouse olfactory system

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Self-avoidance is a fundamental process critical for the establishment of proper neuronal morphology and neural circuitry. Self-avoidance describes the tendency for neurites originating from the same cell to avoid each other while contacting appropriate synaptic targets. The proteins responsible for this process in vertebrates are the clustered Protocadherins (Pcdh), which are differentially expressed in neurons to generate unique cell-surface recognition barcodes. Despite their central role in brain wiring, how these proteins orchestrate self-avoidance in healthy and disease states remains largely unknown. Pcdh-mediated self-avoidance is especially critical in the olfactory system, where stochastic Pcdh expression in olfactory sensory neurons (OSNs) enables the convergence of OSN axons into glomeruli in the olfactory bulb. In the absence of Pcdh, OSNs form clumped, tangled axon terminals that fail to form glomeruli. In vitro studies suggest that for OSN axons to self-avoid, Pcdh proteins engage in highly specific trans-homophilic binding during self-self neurite contacts. How is strong extracellular adhesion transduced into avoidance? Here, we dissect the mechanism of self-avoidance using a combination of in vitro biochemistry, cell culture-based assays, and novel genetic manipulations in the mouse olfactory system. Using these tools, we uncover that a region within the Pcdh intracellular domain acts as a molecular sensor for extracellular binding, bridging self-recognition and self-avoidance.

S26-6 A 3D organoid model of olfactory neurogenesis

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The olfactory epithelium contains two basal stem cell populations that facilitate the nearly life-long ability for neuronal regeneration that is required for us to smell on a day-to-day basis. Horizontal basal cells (HBCs) are generally quiescent and only become active after major injury to the tissue. Globose basal cells (GBCs) lie atop HBCs and are responsible for the normal, homeostatic maintenance of the tissue. Studying the stem cell dynamics of how these two neurogenic stem cell populations replenish olfactory sensory neurons is hampered by a lack of robust culture models. Here, we report the development of a 3-dimensional organoid model that recapitulates the neurogenic cascade while maintaining both HBCs and GBCs in culture. We use this model to demonstrate that while HBCs remain relatively quiescent in culture, they form a critical niche for the rest of the organoid.

S27-1 Integration of contextual task information with odor information via the AON

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The anterior olfactory nucleus (AON), an olfactory network strongly and reciprocally connected with other olfactory areas, has recently been shown to be a hub for the integration of non-olfactory and olfactory information. The AON has been shown to strongly modulate neural processing in the OB, and influences olfactory processing in diverse situations such as social odor memory, contextual processing and episodic memory. Direct input from the ventral hippocampus to the AON is crucial for certain olfactory tasks in rodents by modulating odor responses depending on contextual task information. We present data from a contextual odor discrimination task, in which rodents need to integrate physical context with odor information to obtain a reward. We show that functioning AON and vHC netrowks are needed for the expression of this task, and that these two networks create coherent osciallations when the behaviroal task needs the integration of both contextual and olfactory information. Interestingly, when non olfactory stimuli need to be integrated with context, only the vHC but not the AON are needed to solve the task. We use computational modeling to suggest a mechanism underlying these observations.

S27-2 Neural responses in the AON during social memory formation

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Social recognition is essential for the formation of social structures. Many times, recognition comes with lesser exploration of familiar animals. This lesser exploration has led to the assumption that recognition may be a habituation memory. The underlying memory mechanisms and the thereby acquired cortical representations of familiar mice have remained largely unknown, however. Here, we introduce an approach directly examining the recognition process from volatile body odors among male mice. We show that volatile body odors emitted by mice are sufficient to identify individuals and that more salience is assigned to familiar mice. Familiarity is encoded by reinforced population responses in the anterior olfactory nucleus and posterior piriform cortex and communicated to other brain regions. The underlying oxytocin-induced plasticity promotes the separation of the cortical representations of familiar from other mice. In summary, neuronal encoding of familiar animals is distinct and utilizes the cortical representational space more broadly, promoting storage of complex social relationships.

S27-3 Neuronal Responses in the Anterior Olfactory Nucleus During a Complex Odor Memory Task.

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The anterior olfactory nucleus (AON) is a likely gateway through which spatial and contextual information might influence olfactory perception and memory (Aqrabawi & Kim, 2018, Nat Comm). However, little is known about how AON neurons respond to odor cues in awake behaving subjects performing complex olfactory memory tasks. We recorded AON neuronal responses while rats performed a context-dependent odor memory task in which they had to remember eighteen different odors and keep track of reinforcement contingencies that changed across two distinct environmental contexts, a black box and a white box. Rats learned to perform this task at a high level (~90% correct) and AON neurons exhibited robust responses to the odor cues. Odor-evoked neuronal responses could take the form of increased or decreased firing, and many neurons responded to more than one odor. The response patterns to the various cues were often complex, with some neurons sensitive to the valence of the odor cues and others exhibiting context-dependent responses. We examined population firing patterns and found that we could readily decode the identity and valence of the odors. More surprisingly, we were also able to decode the current context (black or white box) using odor-evoked firing patterns or firing occurring in between odor presentations. These results indicate that AON neurons are strongly engaged during odor sampling and they exhibit a complex array of responses which likely play a key role olfactory memory processes.

S27-4 Knowledge abstraction through overlapping memory engrams

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The engram is the fundamental unit of memory. We hypothesized that engram cells encoding common features across distinct events provide a passive, biological mechanism for generalization. We devised a genetic strategy to exclusively label and manipulate overlapping engram cells (OLEs) and demonstrated

their bidirectional role in transitive inference, a knowledge-dependent form of deductive reasoning. Ca2+-imaging of the anterior olfactory nucleus revealed that OLEs readily develop generalized responses to chemically distinct stimuli when repeatedly presented in sequence. Moreover, OLEs composed a fast-spiking minority, exhibiting locally-synchronized firing, near-simultaneous inhibition of non-overlapping cells, and the dynamical properties of attractors. Lastly, we reveal a series of nested hippocampal-cortical feedback loops underlying the whole-brain olfactory knowledge architecture. Collectively, these data uncover an intuitive and efficient neurobiological substrate for abstract knowledge.

S28-1 Olfaction through the lens of system dynamics and internal context

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Neural coding is an attractive metaphor for sensory system processing in which neuroscientists presume that cortical neurons respond to some objective stimulus features. In olfaction, these features are assumed to be molecules or parts of molecules. However, from the mitral and tufted cells in the olfactory bulb into other olfactory cortical areas, stable neural codes have defied researchers for decades. Neural responses to odors are exquisitely dependent on an animal's internal context, usually associative context. Instead of asking how the olfactory system codes features which researchers define, we instead ask, how does the olfactory system participate in smelling? This moves the question from a computational into a psychological and biological framework. Research on the olfactory system is privileged in this respect. Because we have little idea what features the mind and even the brain care about, we ask the system to tell us how smelling happens. Population dynamics show series of organized states lasting 1-2 sniffs or longer as a rat samples an odor and decides on and executes a response. Early local gamma oscillations constrain olfactory bulb neuronal activity and are modulated by cognitive load and chemical similarity. This state is followed by a sudden and global transition to coherent beta oscillations in the olfactory and hippocampal systems that accompany the rat's decision and response initiation. The state transition can be accomplished by an increase in excitability among granule cells. The explanation does not rely on codes or information transfer and follows a course parallel to psychological states.

S28-2 From sensory RECEPtion to sensory REJECtion - a new look at the sensory system

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The brain operates as a dynamic complex system. Importantly, it is an open system constantly interacting with the environment. At the interface of this interaction lies the sensory cortex, which controls and regulates information flow from the environment, thereby directly impacting the dynamics of the brain system. Accordingly, failures of this sensory gateway and, consequently, dysregulated environmental perturbations could result in drastic state shifts that further escalate into collapses of the complex brain system, giving rise to significant symptoms as observed in various mental disorders. While historically overlooked in the conceptualization of neuropathophysiology, sensory processing has been increasingly recognized, especially through data-driven analyses, to be dysfunctional in major mental disorders such as schizophrenia, PTSD, Autism, ADHD, Parkinson's disease, and so on. Based on a dynamical systems model, this talk will discuss the sensory cortex as the first line of defense of the brain's complex system, whose dysfunctions could contribute to these disorders via interaction with major large-scale neural networks (e.g., the default mode network) and via neural oscillations (e.g., the alpha oscillation) originating in the early sensory circuitry. Compromised sensory cortical inhibition (i.e., sensory

disinhibition) and resulting feedforward neural noise will be highlighted as an important neuropathophysiological mechanism.

S28-3 Timescales of representation

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Spike timing matters. This is clear simply based on the integration time constants of synapses, as well as on more sophisticated synaptic mechanisms such as spike timing-based plasticity. Given the enormous effects that fine-timescale spike timing exerts on neural computation, do brain systems regulate spike timing accordingly, or leave it to chance? And, assuming the former, by what dynamical mechanisms can the necessary regulation of spike timing be maintained? And how can information be represented in patterns of neural activity while respecting the constraints imposed by these dynamical systems? I discuss how the early olfactory system constructs its representations within a dynamical framework rendered robust by both glomerular-layer preprocessing mechanisms and PRING dynamics. Moreover, given that neural activity even in the olfactory bulb is influenced by learning, neuromodulation, and other behavioral state variables, I further argue that a framework of "odor coding" is limiting; instead favoring "representational cascades" as a more robust and generative framework with which to understand activity in brain networks.

S28-4 Respiration coordinates the olfactory cortical code

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In all sensory systems, arrays of receptors respond over both space and time. However, the impact of response timing on downstream neural activity remains unclear. One prominent form of temporal coding is phase coding, where the phase of neural responses relative to an oscillation encodes stimulus information. Despite theoretical support, there is limited empirical evidence that phase coding can viably transmit stimulus information across brain regions.

Here, we investigate how the phase of inputs from the olfactory bulb (OB) to the piriform cortex (PCx) impacts cortical responses. In this system, each odor activates a specific subset of OB glomeruli, which respond at different phases of the sniff cycle. These glomeruli project via mitral and tufted cells to PCx, where individual neurons receive input from multiple glomeruli. While glomerular response phase contains odor information, it is not clear how this phase code is read out in the olfactory cortex.

We optogenetically stimulated small subsets of glomeruli at different respiratory phases while recording spiking responses in PCx of awake, head-fixed mice. Individual PCx neurons are tuned to the phase of glomerular stimulation, and across the population, stimulation phase preferences tile the sniff cycle. Remarkably, the preferred phase of each PCx neuron was constant across different stimulation OB sites. Moreover, phase-tuning diminished when blocking airflow through the nostril. This phase-to-rate coding scheme may facilitate efficient representation of glomerular responses throughout the respiration cycle and demonstrates the causal influence of phasic activity on downstream brain regions.

S29-1 Olfactory cuteness – neural and perceptual hints towards an olfactory Kindchenschema

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The smell of the own baby is a salient cue for human kin recognition and bonding. We hypothesized that infant body odors function like other cues of the Kindchenschema by recruiting neural circuits of pleasure and reward. In two functional magnetic resonance imaging (fMRI) studies, we presented infantile and postpubertal body odors to nulliparae and mothers (N=78). All body odors increased BOLD response and functional connectivity in circuits related to olfactory perception, pleasure and reward. Neural activation strength in pleasure and reward areas positively correlated to perceptual ratings across all participants. Compared to postpubertals, infant body odors specifically enhanced BOLD signal and functional connectivity in reward and pleasure circuits, suggesting that infantile body odors prime the brain for prosocial interaction. This supports the idea that infant body odors are part of the Kindchenschema. The additional observation of functional connectivity being related to maternal and kin state speaks for experience-dependent priming.

S29-2 Chemistry of human body odor: individuality vs. conserved signatures of psychophysiological states

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Human body odor conveys large body of information about our genetic background as well as physiological and psychophysiological states, including diseases and pathologies. This banal statement has a great support from our daily life experiences as well as from the research mainly conducted using olfactory perception studies with human raters or trained dogs. Yet, empirical knowledge on chemical underpinnings of differential body odor is rare, essentially due to past technical limitations in detection and separation of individual analytes from the complex blend of multiple hundreds of small molecules emitted by human body.

With the recent advent of gas phase metabolomics, many previously intangible questions related to human body odor became realistic targets of research. Here, we use a combination of olfactory perception rating and comprehensive two-dimensional gas chromatography coupled with MS detection (GC×GC-TOFMS) to search for axillary body odor patterns characteristic for different psychophysiological states of healthy male donors. More specifically, we analyzed the body odor changes upon sport exercise, upon exposure to psychosocial stress and upon sexual arousal stimulation. In my presentation, I will show that both, perception rating and chemical analyses allowed for efficient separation of control samples from the same donors and samples collected after sport and stress exposure. By contrast, we did not observe a systematic shift in body odor patterns upon sexual arousal. I will also disclose the candidate analytes responsible for the body odor shift among different psychophysiological states.

S29-3 Basolateral Amygdala Lesions Cause Hyperfear Responses to Fear Odor Molecules

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Despite historical misconceptions regarding the inferiority of human olfaction, recent research has highlighted our excellent smell skills, including chemical communication. One pressing question persists: "Do humans use pheromones for social communication?". Abundant experiments have elucidated that BOs emitted by individuals during emotional states, known as “senders”, elicit emotional contagion in “receivers”, thereby synchronizing them for effective communication, notably in fear (fear-specific responses, enhanced amygdala activity). Yet, the human pheromone inquiry requires a more fundamental, interdisciplinary approach. Our recent chemical analysis indicated consistent fear odor chemical signatures across diverse human samples. We synthesized these fear odor molecules to test hypotheses regarding innateness vs. learned mechanisms, typically considered infeasible; yet, patients with Urbach-Wiethe Disease (UWD), a rare genetic disorder, provide a unique natural basolateral amygdala (BLA) lesion model for studying fear due to their heightened reactivity to instinctive fear stimuli and impaired fear learning. Using a mobile olfactometer research set up in South Africa, where UWD is more prevalent, we compared UWD patients (*N* = 5) and matched controls (*N* = 15) with equal smell ability. In a double-blind experiment, all were randomly exposed to 3 odors (fear odor molecules, isovaleric acid, odorless air) while they judged 6 different face morphs (35% fear to 65% fear vs. disgust) as “fear” or “disgust”. The results revealed a significant hyperfear-perception bias in UWD patients (*d*= 1.35). These findings pinpoint the role of the BLA in the possible innate nature of human chemical communication, advancing our understanding of social olfaction.

S29-4 Body odor analysis: current insights and future perspectives

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While many people are aware of the relevance of their sense of smell in relation to food intake and recognition of threats in their environment, it is less known that the sense of smell is also relevant for social communication in humans. This actually goes along with a still limited knowledge about the mechanisms of social olfaction in humans, which is why researchers of different disciplines are currently joining their forces to find out more. In this overview presentation, different approaches for the analysis of body odors are discussed in relation to their usefulness in multi-disciplinary research contexts, aiming to elucidate (odour-active) volatiles contributing to the transfer of information about psychophysiological states of humans. Additionally, the results of collaborative research projects are presented, focusing on the impact of the diet on bodily fluids and the transfer of information about emotions and developmental stage via axillary odors.

S30-1 Evolution of feeding preference in drosophilids

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Food choice is an important driver of speciation and exploration of novel ecological niches. However, we know little about the mechanisms leading to changes in food preference at cellular and molecular level. To study this phenomenon, we use the three closely-related *Drosophila* species *D. sechellia*, *D. simulans* and *D. melanogaster* which dramatically differ in their feeding habits. *D. sechellia,* a host specialist, spends its whole life cycle on a single fruit (*Morinda citrifolia*, noni) - the latter two are generalists living on various substrates. In several quantitative feeding assays we can recapitulate the preference for noni in *D. sechellia*. Using neurogenetics, we identify sweet and bitter sensing neurons as main drivers for this shift in behaviour and compare their physiology between species. We establish a causal link between genetic changes in one single gustatory receptor, peripheral neuron responses in bitter sensing cells of the labellum and behavioural divergence between species. Through volumetric Calcium imaging in the ventral brain, we detect that in addition to peripheral physiology species-specific processing of noni detection in somatosensory circuits alters feeding preference. Our data supports a model where multiple species-specific modifications lead to altered food consumption across related species.

S30-2 Independent origins of new olfactory sensory neuron populations

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Analogous to vertebrates*, Drosophila*'s olfactory sensory neurons (OSNs) express a single Odorant receptor (*Or*) gene. This extremely specific pattern of expression, together with high *Or* duplication rates, raises a fundamental question: How is the evolution of new *Or*s "coordinated" with the development of OSNs so that a new receptor is uniquely expressed in its corresponding neuron – in other words, how do new OSNs evolve? A major challenge in understanding the molecular and cellular processes underlying this process is identifying species that have evolved new OSN populations. To address these questions, we have been developing the most duplicated/deleted *Or* subfamily in the *D. melanogaster* species group, the *Or67a* subfamily, as an experimental system. Molecular evolutionary analyses of the *Or67a* subfamily in 17 fly species have revealed a remarkably high rate of receptor turnover and translocations, with several duplicates experiencing adaptive protein changes. *In vivo* electrophysiological recordings substantiate fast functional diversification. Surprisingly, contrary to the expected "one receptor-one neuron" expression pattern, we found that most of the *Or67a* duplicates are co-expressed with one or more ancestral receptors in the same OSN population. Despite broad *Or67a* co-expression, we have identified two independent instances of *Or67a* duplicates that have "escaped" co-expression and evolved novel cell-specific expression. These are the first documented cases linking species-specific *Or* copy number changes to novel OSN expression. Our *Or67a* studies provide unique "snapshots" into the early molecular and cellular evolution of the fly's olfactory system and provide the foundation for studies into the developmental origin of these changes.

S30-3 Evolutionary, expression, and functional analyses of a cryptic Or/Gr homolog conserved in flies, humans, and beyond

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Insect Odorant and Gustatory receptors (Ors and Grs)—which are unrelated to GPCRs—inhabit the "twilight zone" of sequence similarity, where it is difficult to align sequences and therefore infer homology and phylogenetic relationships. Recently, we leveraged *ab initio* protein folding to perform structure-based identification and phylogenetic analysis of distant Or/Gr relatives. Surprisingly, these efforts revealed homologs across the tree of life, including in humans, unicellular eukaryotes, and prokaryotes, collectively defining a protein superfamily named 7-Transmembrane domain Ion Channels (7TMICs). Among eukaryotic 7TMICs, two clades predate multicellular life: Class-A 7TMICs, a rapidly evolving clade that includes Ors/Grs and Gr-like proteins (Grls); and Class-B 7TMICs, which include human homologs. Comparative genomics reveals that, unlike Ors/Grs/Grls, Class-B 7TMICs are generally well conserved at the sequence level and show remarkably little copy number diversity across taxa. Furthermore, these proteins show putatively conserved expression in male reproductive tissue in invertebrates and vertebrates. In *Drosophila,* we have confirmed *in situ* expression of a Class-B 7TMIC in the male germline, with notable expression in post-meiotic, elongating spermatids. Preliminary functional experiments suggest that this protein is required for male fertility, highlighting the possibility of non-neuronal functions of proteins within this superfamily.

S30-4 Evolution of olfactory circuits in the pandan-specialist D. erecta

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When animals adapt to new ecological niches, the olfactory system — used to find food and mates — is placed under enormous evolutionary pressure. In drosophilids host-specialisation evolved repeatedly, accompanied by changes in olfactory circuits. While there is plenty of evidence that olfactory receptors are highly divergent and contribute to novel adaptations, we are yet to comprehend the extent to which nervous systems evolve by changing central neural circuits.

To establish the relative contribution of peripheral and central neural circuit changes in the evolution of olfactory circuits, we are comparing two fly species adapted to different food sources: *Drosophila melanogaster*, a generalist with a wide preference for rotting fruit, and *Drosophila erecta*, a seasonal specialist on pandan fruit.

We show that pandan purée from fruits collected in the field and single odours identified from the pandan bouquet are more attractive to *D. erecta* than *D. melanogaster* in two behavioural tests: a two-choice odour trap and a high-throughput egg-laying assay.

We identify changes in the underlying neural circuits which explain this behavioural divergence by combining genetic tools in *D. erecta* with *in vivo* volumetric calcium imaging and neuroanatomy. We also find evidence of convergent evolution between *D. erecta* and *D. sechellia*, another specialist species, in one olfactory pathway.

Our work highlights how olfactory neural circuits can undergo different evolutionary paths, with changes in both peripheral and central components, as animals adapt their behavioural repertoires.

S30-5 A new dimension to the olfactory system: lncRNAs and a micropeptide upregulated by hunger

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Insects rely heavily on their astonishing sense of smell to navigate through our complex environment. The fly olfactory system can detect minuscule amounts of a wide range of odors, and can also finely tune its sensitivity based on the internal state of the animal. Major questions remain about the molecular mechanisms by which the olfactory system changes its sensitivity. Long non-coding RNA (lncRNA) is unexplored in the fly antenna, yet many features of lncRNA could be exploited in olfaction.

We have identified a remarkable diversity of lncRNAs in the fly's main olfactory organ, the antenna, by analyzing bulk and single-nucleus RNA-Seq datasets. We have generated a lncRNA-to-neuron map, work that revealed a new layer of complexity across the olfactory receptor neuron repertoire of the antenna. Particularly striking, we identified species-specific lncRNAs that are enriched in pheromone sensing neurons, suggesting a potential role in mating and/or species recognition.

We then compared the transcriptomes of starved and fed flies, and identified an ANtenna-enriched RNA that is Upregulated by Starvation, which we renamed *ANRUS*. *ANRUS* is classified as a ncRNA and shares many characteristics with other ncRNAs. However, to our surprise, *ANRUS* encodes a secreted micropeptide that can be readily detected by antibody staining in the lymph of pheromone-sensing sensilla. We are currently exploring the potential contribution of *ANRUS* in the modulation of pheromone sensing under starvation.

Our work also provides a foundation to explore roles of a wide variety of other lncRNAs in olfactory function and neuronal modulation.

S30-6 Response plasticity of Drosophila olfactory sensory neurons

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The majority of insect olfactory receptors belong to two distinct protein families, the ionotropic receptors (IRs) which are related to the ionotropic glutamate receptor family, and the odorant receptors (ORs) which evolved from the gustatory receptor family. The performance of ORs is fine-tuned by various signaling cascades. They can, for example, be sensitized by appropriate stimulation. Sensitization refers to the amplification of a weak olfactory signal when the stimulus is repeated within a specific time window. This is manifested at the level of olfactory sensory neurons (OSNs) located in the antenna of *Drosophila melanogaster*. In our study, we investigate whether sensitization is a widespread property in a set of seven OR expressing OSNs, as well as the mechanisms involved. First, we characterize and compare differences in spontaneous activity, response velocity and response dynamics among the selected neurons which express different receptors with distinct valences and tuning properties. Second, we show that sensitization is not a general property. In our selected OSNs population, it occurs in those responding to food odors. Moreover, we prove mitochondria to play an active role in sensitization by contributing to the increase in intracellular Ca^{2+} upon weak receptor activation. Thus, by using a combination of single sensillum recordings (SSR), calcium imaging and pharmacology, we widen the understanding of how the olfactory signal is processed at the periphery.

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S31-1 The effect of social experience on gene expression, circuit function and behaviors

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Social experience has a profound impact on animal behaviors, yet the molecular and circuit-based mechanisms remain unclear. In Drosophila, social isolation increases courtship vigor in wild-type males, whereas monosexual grouping suppresses it. Correspondingly, social isolation heightens the baseline and evoked neuronal activity in central courtship circuits, particularly elevating the evoked activity of P1 central courtship command neurons. We previously have shown that in peripheral pheromone sensing neurons social experience modulates the expression of *fruitless,* a critical courtship regulator expressed in 2000 interconnected neurons that constitute the majority of the courtship circuit. Single-cell RNA sequencing from *fru*-positive neurons in grouped and isolated male brains revealed that social isolation impacts *fru* expression in distinct neurons within the courtship circuit. Furthermore, numerous genes associated with neuromodulation, behavior regulation, learning and memory, and synaptic plasticity are differentially expressed in response to social experience.

In the olfactory system, Or47b and Or67d receptors are expressed in *fru*-positive neurons tuned to fly pheromones. We found that the pheromone-sensing Or47b olfactory circuit contributes to the suppression of male-female courtship in males raised in monosexual groups, while Or67d pheromone circuits do not alter the impact of social experience on courtship. Intriguingly, Or47b and Or67d circuits exert opposite effects on the expression of certain genes, revealing that different social signals in the environment trigger distinct transcriptional responses in the brain. These findings provide valuable insights into the fundamental mechanisms by which social experience drives behavioral adaptations through the modulation of genes critical for neural circuit structure and function.

S31-2 Drosophila melanogaster eavesdrops on a yeast quorum-sensing signal to locate food sources

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Drosophila melanogaster and *Saccharomyces cerevisiae* are synanthropic species that feed on decaying fruits, a food source rich in sugar. It has been hypothesized that insects such as *D. melanogaster* might use volatiles produced by fermenting yeast to locate profitable food sources, whereas yeast might rely on the insects to disperse to new food patches. Our recent findings show that *D. melanogaster* can be either attracted by different volatile molecules produced by cultures of S. cerevisiae at different stages of fermentation. More specifically, we found that the D. melanogaster olfactory system has evolved to detect a yeast quorum-sensing signal produced by yeast at later stages of fermentation as they become nutrient-depleted. Attraction to this quorum-sensing signal is species-specific and highly variable across *D. melanogaster* populations, suggesting that it is a recently acquired trait. Manipulating this signaling pathway affects both yeast dispersal and *D. melanogaster* survival, suggesting that the interaction

between the two species might be mutualistic. Altogether, our data suggest that *D. melanogaster* has evolved the ability to locate profitable food sources by eavesdropping on signals used by *S. cerevisiae* to communicate their quorum status to conspecifics. This type of interspecies communication might be used by *S. cerevisiae* to recruit *D. melanogaster* as a dispersal vector to high-density habitats.

S31-3 Neuronal and molecular mechanisms underlying gustatory adaptation

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Animals modulate their behavioral responses to continuous or repetitive sensory stimuli, a phenomenon called sensory adaptation, which enables them to function effectively in challenging or overly stimulating environments. During sensory adaptation, sensory neurons or circuits gradually decrease their responses to continuous or repetitive sensory stimuli. Here, we studied gustatory adaptation in the fly, *Drosophila melanogaster.*Similar to other animals, flies reduce their responsiveness to tastants with repeated exposure, a phenomenon called gustatory adaptation. Previous studies have focused on the circuit basis of gustatory adaptation in the fly chemosensory system. However, gustatory neurons reduce their firing rate during repeated stimulation, suggesting that cell-autonomous mechanisms also contribute to this process. Here, we used deep learning-based pose estimation and optogenetic stimulation to first demonstrate that continuous activation of sweet-taste neurons causes gustatory adaptation in flies. Next, we conducted a transgenic RNAi screen to identify genes involved in this process and found that knocking down *Histamine-gated chloride channel subunit 1* (*HisCl1)* in the sweet-taste neurons significantly reduced gustatory adaptation. Using single sensilla recordings, we showed that sweet-taste neurons reduced their firing rate with prolonged exposure to sucrose. Finally, we showed that flies lacking *HisCl1* in sweet-taste neurons increased their consumption of high-concentration sucrose solution compared to control flies. Together, our results demonstrate that HisCl1 tunes spike frequency adaptation in sweet-taste neurons and contributes to gustatory adaptation and food intake regulation in flies. Since HisCl1 is highly conserved across many dipteran species, our findings open a new direction in studying insect gustatory adaptation.

S31-4 Learning through sight and smell: Exploring the correlates of bimodal sensory integration in Drosophila

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Insects require multisensory signals to navigate natural environments and show remarkable abilities to learn and form memories associated with them. This acquired information is essential to make crucial decisions at a later point in time. Conventional conditioning experiments report strong learning ability in vinegar flies (*Drosophila melanogaster*) using olfactory cues. In our study, we established a T-maze choice assay that combines the presentation of both visual and olfactory stimuli in an aversive conditioning paradigm to study the effect of bimodal integration on learning performance. We show that the presence of additional information during training differently affects the strength of learning for the individual olfactory and visual components. We also utilized this behavioral paradigm to compare and contrast the olfactory and visual learning abilities of different Drosophilids. The results from these

behavioral experiments provide evidence for the presence of neuronal substrates that can integrate sensory information to form specific bimodal associations. Based on the previously published brain connectome data for this model organism, we are currently investigating using transgenic reporter lines and two-photon functional imaging the role of higher brain regions such as the mushroom bodies and the lateral horn in multimodal information processing. The talk will summarize our recent insights into the neural correlates of sensory integration in *Drosophila*.

S31-5 Evolution of temperature preference behavior in Drosophila

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How temperature preference evolves during the colonization of new environments is not known. We show that at least two distinct neurobiological mechanisms drive the evolution of temperature preference in Drosophila. Fly species from mild climates (*D. melanogaster, D. persimilis* etc.) avoid heat, and we show that this can be fully explained by differences in the activation threshold of the peripheral hot receptor neurons. Desert-dwelling *D. mojavensis* are instead attracted to heat. We demonstrate that this is due to a valence switch, from aversive to attractive, in how the brain processes input from the peripheral receptors. Although insects are ubiquitous, few species inhabit thermal extremes. Our findings illustrate how adaptation to desert life in Drosophila involved a remarkable rewiring of the thermosensory system.

S32-1 Machine learning for bitter taste: data, surprises and new tools

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Bitter Taste GPCRs (TAS2Rs) are expressed on the tongue and play a key role in food choice and consumption. There are 25 TAS2Rs subtypes, and a myriad of chemically diverse ligands[1].

By integrating machine learning and modeling with experimental testing, we expand the bitter chemical spaces and explore the roles of ectopic taste receptors. BitterMatch, our ML approach to computationally match molecules to bitter taste receptors[2], led to prospective discovery of bitter off-targets for odorants[3].

Interestingly, while similarity of ligand-binding sites of TAS2Rs emerged as an important feature of BitterMatch, the new CryoEM structure of a TAS2R-ligand complex (Peri et al, unpublished) suggests surprising differences from previously assumed ligand binding modes and poses.

Predicting bitterness based on molecular structure can be very successful, but is limited to a small fraction of the natural products chemical space. Indeed, most of the chemical space is unknown, and even for species and samples that have been analysed by metabolomics approaches, the majority of compounds remain unassigned to chemical structures. I will present the BitterMasS machine learning tool (Ziaikin et al, unpublished) for predicting bitterness directly from mass spectra, and its potential for “tasting” the dark (unassigned) metabolome.

Dagan-Wiener, A., et al., *BitterDB: taste ligands and receptors database in 2019.* Nucleic Acids Research, 2018.

Margulis, E., et al., *BitterMatch: recommendation systems for matching molecules with bitter taste receptors.* Journal of Cheminformatics, 2022.

Margulis, E., et al., *Bitter Odorants and Odorous Bitters: Toxicity and Human TAS2R Targets.* Journal of Agricultural and Food Chemistry, 2023.

S32-2 Mapping the boundaries and terrains of olfactory space

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Due to the complexity of its stimulus-percept relationship, olfaction has been a sense without a map. The last decade has seen breakthroughs in structure-odor modeling enabled by the combination of modern machine learning algorithms and ambitious, large-scale data collection campaigns. We present two recent success stories that demonstrate the potential of this approach. First, we trained a model to predict whether a molecule was odorous or odorless - that is, to define the boundaries of olfactory stimulus space - using a chemically diverse dataset of over 1,900 molecules. We additionally performed rigorous quality control on this dataset to correct errors. When we used this quality-controlled dataset to train machine learning models, we found that features that drive transport of molecules to olfactory receptors (volatility and hydrophobicity) are sufficient to reliably classify novel molecules as odorous or odorless (AUROC = 0.97). Next, we trained a model to predict odor character from molecular structure using a dataset of 5,030 molecules described in either GoodScents or Leffingwell's fragrance material databases. To prospectively validate this model, a 15-subject trained panel evaluated 400 previously uncharacterized molecules in duplicate using a 55-word lexicon and the rate-all-that-apply method, generating stable odorant descriptions (panel mean test-retest R=0.80). We find that predictions from molecular structure alone are sufficient to achieve super-human performance. Across all molecule-by-label combinations, the median panelist predicts the panel mean with an R of 0.47; the model just surpasses this mark (R=0.49). New models built with improved datasets will bring the map into sharper focus.

S32-3 From Molecule to Perception: Development of a Chemical-Perceptual Space of Olfaction (CROWN)

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Olfactory sensations are evoked by the chemical binding of molecules to olfactory receptors. While the olfactory receptor genome is decoded and the central circuitry of olfactory pattern recognition is largely known, it is still not possible to predict, which chemical molecule properties lead to which odor impression. Previous attempts to solve the mystery of the chemical-perceptual odor space have been conducted in highly trained experts and showed promising results in predicting perception for these expert panelists. However, hardly any datasets exist, which characterize laymen odor perception. This is desirable, as accurate prediction of odor perception is not merely of interest in basic research, but also has relevant applications in the emerging field of digitizing olfaction. The aim of this study is to provide a large-scale laymen dataset of olfactory perception and investigate how different measures of perception are related to chemical structure. For that purpose, 1215 participants were asked to freely describe and rate a subset of 74 chemically diverse monomolecular odors. In line with previous findings, our results show significant associations of perception with chemical structure, however, only explaining around 2-3% of variance in the respective measures. At the same time, we see a high stability across time and experimental condition, as well as relations to previous datasets using the same odor molecules. In conclusion, we present a large dataset characterizing laymen olfactory perception. While our study unveils significant associations between perception and chemical structure, the limited explanatory power underscores the complexity and interindividual variability of odor perception.

S32-4 Predicting perceptual similarity from physicochemical properties: The path to digitizing smell

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Digitizing smell, namely transfer of odor across IP, has been a long-time goal in science and technology. Uncovering the rules linking odorant structure to odorant perception has been viewed as a condition for achieving this goal. With this in mind, repeated efforts across decades of research have attempted to systematically link molecular features to specific verbal descriptors such as “garlicky”, or to specific perceptual axes such as “odorant pleasantness”. Here we will argue that these efforts by our group, and by others, were misguided, and the only meaningful or necessary prediction is that of perceptual similarity. We will argue that if you can effectively predict odor perceptual similarity from odorant structure, you can effectively digitize smell. We will substantiate this claim by presenting an algorithmic approach that predicts similarity, and demonstrate its use in the recreation of target odorants from a limited set of odor primaries.

S33-1 Unusual connectivity and coding in the olfactory system of larval amphibians

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Glomeruli are the functional units of the vertebrate olfactory bulb connecting the axons of olfactory receptor neurons with dendrites of bulbar projections neurons. In amphibians, these two circuit elements regularly branch and innervate multiple, spatially distinct glomeruli. Using functional multiphoton-microscopy and cell tracing techniques, we investigated the impact of this wiring on glomerular module organization and odor representations on multiple levels of the olfactory bulb network of larval African clawed frogs (*Xenopus laevis*). Glomerular regions are dominantly tuned to one or a small set of structurally related amino acid odorants. Thereby, the identity and frequency of glomerular regions vary

between animals. The organization of glomeruli is not stereotypic between animals, and the juxtaposition of glomeruli does not indicate odor-tuning similarity. Bifurcating axons of olfactory receptor neurons can be associated with amino acid-responsive glomeruli. Projection neurons innervate distinct glomerular units in a coarse topological manner. Furthermore, we identified bifurcating axons of olfactory receptor neurons and multi-dendritic projection neurons that connect to common sets of glomeruli. Together, these results demonstrate that in larvae of *Xenopus laevis*, the glomerular odor map to amino acids is neither stereotypic between animals nor chemotopically organized. We conclude that odor map heterogeneity is caused by the coexistence of a variety of different intermingled glomerular modules. The consequences of this unusual wiring on the functioning of the olfactory system are currently being investigated.

S33-2 Insights into the quantitative anatomy of the olfactory system of cartilaginous fishes

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Chondrichthyes possess large and complex lamellar olfactory organs, along with large olfactory bulbs in the brain. These morphological features, coupled with their anecdotal evidence of an exceptional sense of smell, their status as the earliest-diverging group of jawed vertebrates, and the increasing amount of molecular data, render this clade interesting for elucidating the relationship between olfactory morphology, molecules, and function. Quantifying the morphology and cell composition of the olfactory organs and bulbs enables comparison among species and the statistical treatment of the olfactory system. Surprising results emerge from this approach in Chondrichthyes. For instance, the number of lamellae in the olfactory organs does not correlate with the sensory surface area, challenging the common notion that a lamellar organ serves to accommodate more sensory surface area within a given volume. Quantifying cells has allowed for the calculation of the ratio between neurons in the olfactory epithelium and those in the olfactory bulb, a novel proxy of convergence in the olfactory system. Calculating this ratio in 21 cartilaginous fish species and, preliminarily, in a few mammals, has shown that it is larger in the former by a factor of 100, suggesting that relatively little effort is devoted to odorant discrimination in Chondrichthyes. Molecular evidence supports these findings: while mammalian olfactory receptors number from hundreds to over a thousand functional genes, cartilaginous fishes possess only a few dozen receptor genes, mainly within the V2Rs family. These insights indicate that the olfactory systems of Chondrichthyes are finely tuned for highly sensitive prey detection.

S33-3 Modeling olfactory dysfunction and degeneration in neurological diseases using adult zebrafish

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Olfactory dysfunction is a common disability that significantly reduces the quality of life and well-being of those who present it and is a common sequela of neurological diseases and brain trauma. Unfortunately, olfactory loss does not spontaneously subside in over 90% of individuals. This highlights a critical need to advance our understanding of olfactory dysfunction and subsequent recovery mechanisms. An important drawback for advancing the field is the limited ability of the adult mammalian nervous system to regenerate after injury and disease. On the other hand, zebrafish exhibit astounding and lifelong neural plasticity and regenerative potential throughout their lifetime, including in the olfactory system, making them an excellent model for studying olfactory degeneration and recovery.

In this work, we used adult zebrafish to develop two novel models to study the relationship between neurological diseases and olfactory dysfunction. To model brain trauma, we produced excitotoxic focal lesions in the olfactory bulb. To model brain ischemia, we exposed fish to acute hypoxic conditions. Our results indicate that in both models, neural insults related to trauma or low oxygen led to structural degeneration in all anatomical components of the olfactory system, concomitant with olfactory functional loss. We also characterized a subsequent olfactory system structural and functional recovery to pre-lesion and pre-hypoxic exposure within 21 and 5 days, respectively.

Understanding mechanisms that underlie adult neural repair and recovery in the olfactory system might provide clues that could potentially be used for stimulating olfactory regenerative strategies in other vertebrates, including humans.

S33-4 A neural substrate for motivated behavior following olfactory learning in zebrafish

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How learning enables odor cues to evoke food-seeking motivation and its underlying circuit mechanisms remain largely unknown. Here we use a simple behavioral paradigm for appetitive olfactory conditioning in adult zebrafish and analyze brain regions that are activated after learning. Infusion of a synthetic odorant into a test tank does not elicit behavioral changes in naive zebrafish, whereas repeated pairings of the odorant infusion with feeding result in odorant-evoked attraction of zebrafish prior to feeding. Following the probe trial, the number of *c-fos*-positive cells in a specific subnucleus of the thalamus is significantly greater in paired group than that in unpaired group. We also find that *c-fos*+ cells increase in number in the thalamic subnucleus upon exposing naive zebrafish to a novel environment. Furthermore, the thalamic *c-fos*+ cells in both the paired group and the novel environment group are a specific population of neurons expressing corticotropin-releasing hormone (*crh*) gene. These results suggest that the activation of the *crh*+ thalamic neurons represents a brain state common to motivated behaviors including the appetitive behavior evoked by a reinforced odorant and the exploratory behavior in a novel environment.

S34-1 Sensory processing in Drosophila taste projection neurons

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How do neural circuits in the brain interpret taste inputs and generate appropriate behavioral responses? We are addressing this question in *Drosophila melanogaster*, which offers unique tools to study neural circuits at single-cell resolution and investigate how each neuron's connectivity, response properties, and behavioral functions are related. In flies, taste sensory cells connect to a diverse repertoire of downstream neurons, including local neurons as well as taste projection neurons (TPNs) that relay information to the higher brain. Our goal is to understand the logic of taste processing in TPNs. First, we are using calcium imaging to determine how TPNs encode and transform sensory information. Our preliminary data suggest that TPNs vary in which tastes they respond to, their breadth of tuning, response dynamics, and state-dependent modulation, suggesting that the taste system employs parallel encoding

of different stimulus features. Second, we are examining how each TPN type contributes to behavior by combining optogenetic manipulations with assays to measure a variety of behaviors, including feeding, locomotion, spatial preference, and learning. Our results thus far show that each TPN regulates a subset of behaviors and different TPNs can have overlapping roles, suggesting a combinatorial model in which different behaviors are regulated by different subsets of TPNs. Finally, we are using connectomic analyses to identify neurons downstream of TPNs and determine the degree of convergence or divergence between different TPN types. Together, these studies have begun to reveal the logic and functional organization underlying early stages of central taste processing in the fly brain.

S34-2 Tastant-Evoked Responses Of Human Fungiform Taste Bud Cells Are Dynamically Shaped By Neuropeptide Y Family Peptide Signaling

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Metabolic disorders such as obesity and type two diabetes mellitus are associated with abnormal food intake. Several gut endocrine hormones are known to influence feeding and body mass accumulation and these signaling systems are thought to be potential therapeutic targets for such disorders. We have previously shown that peptide tyrosine-tyrosine (PYY), a satiety signal peptide and member of the Neuropeptide Y (NPY) family, is present in the saliva of both humans and mice. Furthermore, the selective augmentation of salivary PYY(3-36) affects taste responsiveness, food intake, and body weight in normally fed and diet-induced obese mice. However, the exact (molecular) mechanisms this responsiveness remain unknown. Several peptide signaling systems, including those of the NPY family, have been shown to be present in taste bud cells (TBCs), suggesting that they may play a role in modulating TBC function and taste information communication. We assessed whether the presence of NPY family peptides directly influenced the functional response measures of cultured human fungiform TBCs to prototypical taste stimuli using calcium imaging and adenosine triphosphate measurements. We found a significant impact of multiple NPY family peptides on both functional endpoints in response to multiple taste stimuli and that these results were mediated by NPY family peptide receptors. Furthermore, these effects were bidirectional and diverged across individual members of the NPY peptide family. Taken together, these data support the notion that peripheral taste function could be subject to dynamic modulation, potentially in the context of metabolic state or environmental conditions.

S34-3 Predicting the Sweet Spot: A New Frontier in Sensory and Consumer Science using AI Predictive Modeling to Optimize Natural Non-Caloric Sweeteners

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Overconsumption of sugar is associated with obesity, diabetes, and cardiovascular disease, with rates on the rise globally. Low- and no-calorie sweeteners are utilized to reduce sugar consumption, but these alternative sweeteners differ notably from sucrose in both taste and functionality. Furthermore, preference for clean label and natural products is on the rise, and consumers seek sugar-reduced and zero sugar products that are in line with these desires. With the variety of sweet tasting molecules available, testing sweetener blends via conventional sensory methods is inefficient and would yield incomplete results. We can leverage AI to customize and improve formulations for different products by connecting ingredients,

chemical and physical measurements, descriptive analysis, and consumer preferences to create solutions that satisfy unmet consumer needs for both taste and healthfulness.

Here we present a case study on sweetened beverages in 5 different countries: US, UK, Brazil, Mexico, and India which uncover the differences in taste preferences and drivers of liking across countries. We used an iterative approach to train our model and optimize sweetener solutions based on sensory data and an understanding of how sweet-tasting molecules can elicit different perceptual responses. Beyond sensory drivers of liking, our model reveals ingredient drivers of liking and predicts novel combinations of sweetener molecules tailored to specific consumer segments. Our predictive model illustrates the power of utilizing human perceptual data along with an understanding of sweet taste perception to create targeted solutions that better anticipate consumer needs and aid development of customized healthful innovations.

S34-4 Allulose stimulates multiple sweet taste pathways in human taste cells

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Allulose (D-psicose) is a rare natural sugar found in small quantities in some fruits and other plant-based foods. Allulose has a very similar taste and texture to sucrose, but because it is not absorbed or metabolized it has only a fraction of sucrose's calories. We used cultured human fungiform papillae (HBO) cells to determine which sweet taste signaling pathways allulose stimulates. Allulose activated the canonical sweet taste receptor (T1R2+T1R3) and multiple downstream signaling components (e.g., PLCβ2, adenylyl cyclase 3, and TRPM5). In contrast to glucose and sucrose, allulose was not metabolized to generate ATP and thus did not stimulate the metabolic pathway as defined by ATP-gated K+ channel (KATP) activity. However, allulose was transported into taste cells by multiple sugar transporters (SGLT2, GLUT2, GLUT4 and GLUT5). We conclude that activation of the sweet receptor and transport into taste cells without intracellular metabolism underlies allulose's sugar-like sweet taste and low calorie profile.

S34-5 Oral sensory-metabolic interactions subserving sugar intake

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Taste plays an important role in nutrient selection, and converging lines of evidence suggest that proteins involved in digestion, glucose transport and metabolism are expressed in taste cells. In a series of studies in mice, we investigated if these intermediaries contribute to the ability to rapidly discriminate glucose from other sugars and sweeteners, and bias ingestive decisions towards expedient sources of energy. Using multiunit electrophysiology, we discovered that glucose evokes a discernable pattern of neural activity from fructose in gustatory neurons located within the nucleus of the solitary tract. These responses are honed by dietary experience and do not require sweet receptor signaling. In line with this, mice can take advantage of both metabolism-dependent and -independent actions of oral glucose to

guide nutrient choice. The results further showed that, although glucose-sensing is not dependent upon sweet input, sweet signaling is critical for integrating nutritional state with metabolic sensing in taste cells. Metabolism-dependent mechanisms also contributed to a diet-induced preference for the taste of a glucose disaccharide, maltose, suggesting that more complex sugars are rapidly cleaved to glucose at the taste cell to enable greater sensitivity for these substrates. In a final set of experiments, we found that the α-glucosidase maltase glucoamylase (*Mgam*) is upregulated in the taste papillae by a sugar diet and in mice that are sweet-subsensitive, and shRNA-mediated silencing of *Mgam* in the taste fields reduced the avidity for maltose. Collectively, these results identify novel pathways through which the body maximizes its ability to rapidly detect glucose-yielding carbohydrates.

S34-6 Circuit and Genetic Basis of Negative Valuation of Sweet Taste in Drosophila

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Sugar is a well-known appetitive feeding tastant for flies. However, recent evidence suggests that it can also decrease option value in a non-feeding decision-making task. Specifically, flies accept a sugary agarose for egg-laying when it is the sole option but reject it when a sugar-free agarose is available. The neural and genetic mechanism by which sugars devalue option for egg-laying is not well understood, but input from the leg sweet neurons is critical. Here we identified a circuit that converts input from the leg sweet taste neurons into a negative value signal for egg-laying decision-making. First, we identified a group of SEZ-targeting neurons that are post-synaptic to the leg sweet neurons and required to devalue sweet options for egg-laying. Next, we found that these SEZ-targeting neurons synapse onto specific protocerebrum-targeting projection neurons, and, like their presynaptic partners, these neurons also respond to sugars and are required to devalue sweet options for egg-laying. Notably, these 3rd order neurons are GABAergic and inhibit the egg-laying command neurons both directly and indirectly. This devaluing circuit is task specific and does not impact feeding. Lastly, genetic and genomic analysis of an African natural variant that prefers sugary agarose for egg-laying identified a single gene whose expression change in this circuit drives sugar preference for egg-laying. In conclusion, we have uncovered a novel circuit that confers a negative value to sweet taste and showed how its genetic modification diversifies flies' sugar valuation in nature.

S35-1 Pheromonal information processing in the bee brain

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Every species must efficiently perceive and process stimuli from its environment to ensure survival and reproduction. As social complexity increases, individuals encounter a greater volume of information. Eusociality, the highest form of social organization, is predominantly observed in insects, with olfaction serving as their primary mode of communication. The genus Apis is composed of up to 15 species of eusocial honey bees, including the western honey bee *A. mellifera*. In this study, our aim is to uncover the

neuronal mechanisms that enable honey bees to distinguish pheromones from other odors, thereby ensuring colony survival. We initially focus on sexual communication, as a distinct neuronal pathway has already been identified in the processing of the queen's sexual pheromone, 9-oxo-decenoic acid (9-ODA). This pheromone plays a crucial role in male attraction to virgin queens during mating. 9-ODA is detected by the overexpressed sexual olfactory receptor in males, known as the OR11, and which activates the largest glomerulus within the male antennal lobe, termed macroglomerulus 2 (MG2). Our recent research suggests the presence of a specialized neural pathway for detecting 9-ODA across various honeybee species, with each species responding to a unique set of secondary ligands. To confirm whether this pathway exclusively processes 9-ODA within the male brain, we generate transgenic males with the OR11 gene deletion. Our goal is to observe the resulting effects on both neuronal pathways and behavior. These projects will provide valuable insights into whether 9-ODA is indeed processed solely through this unique neuronal pathway, as hypothesized.

S35-2 Insect chemical communication in a polluted world

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Most insects use chemical cues like pheromones for their sexual and social behavior. During the Anthropocene we are facing increasing amounts of oxidant pollutants like nitric oxides and ozone in the atmosphere. Due to their oxidizing power these pollutants can degrade many of the compounds the insects rely upon. Sex pheromones for example often contain carbon double bonds that make these compounds sensitive to degradation. Here we show that behavioral effects of such a pollutant-induced degradation can be dramatic. Female flies lose interest in their conspecific mates, after the latter have lost most of their pheromones due to exposure to slightly increased levels of ozone. Apart from sexual communication also social communication in ants can become affected. We found that ants after being exposed to increased levels of ozone become attacked by their nestmates. Nestmate recognition of ants basically relies upon saturated cuticular hydrocarbons that are not easily degraded by ozone. However, after ozone exposure we observed that the few unsaturated hydrocarbons (i.e. hydrocarbons containing carbon double bonds) in the colony-specific blends became diminished by ozone exposure, which obviously was sufficient to corrupt nestmate recognition. As all the described effects were observed already at ozone levels that have been repeatedly reported for urban areas, the corruption of insect sexual and social behavior might be another factor that contributes to the ongoing insect decline.

S35-3 Pheromones and learning: how social signals modulate individual performance.

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As social insects, honey bees rely heavily on pheromone communication to regulate individual behaviours within a colony. Pheromone signals do not only trigger specific responses; they also modulate cognitive processes involved in plastic behavior. While individual learning processes have been extensively studied in this model invertebrate species, only rather recently have some studies shown how they are modified in response to pheromones. I will present published and unpublished results from our group showing that exposure to a pheromone component does modulate learning performance, possibly reflecting a contribution to a more general response to this signal. I will also provide evidence for the key role played by a neuropeptide in such modulation, and for the capacity of non-pheromonal odorants to counteract the

effect of the pheromone. Altogether, these results illustrate the fact that pheromones have a wider action spectrum than originally thought, but they also open avenues to improve resilience of honey bees under certain stress conditions.

S35-4 An anti-cannibalistic pheromone in the migratory locust

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All over the animal kingdom cannibalism occurs as a way to enrich diets. Among dense populations of migratory locusts, *Locusta migratoria*, cannibalism is prevalent. We studied olfactory interactions connected to this phenomenon. We show that in dense swarms, locusts produce an anti-cannibalistic pheromone; phenylacetonitrile (PAN). The degree of cannibalism co-varies with the production of PAN in a density-dependent way. After identifying the anti-cannibalistic effect of PAN we proceed to study the olfactory background to its effect. By using the *Drosophila* empty neuron system we identify the olfactory receptor that detects PAN. Having access to this information we use genome editing to render this receptor non-functional. This manipulation totally abolishes the negative response towards PAN. We then proceed to knock out the gene underlying PAN production. Locusts lacking the capability to produce PAN lose its protection and are more frequently exposed to intra-specific predation. In conclusion, by using state-of-the-art technology we reveal an anti-cannibalistic feature built on a specifically produced pheromone within dense locust swarms. The system is likely to play an important role in locust population ecology and offers interesting possibilities for future investigations of locust swarm dynamics.

S35-5 Cryptic female choice in response to male pheromones in Drosophila melanogaster

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Females control the paternity of their offspring by selectively mating with males of high quality. In species where females mate with multiple males, females may bias offspring paternity by favoring the sperm of one male over another, a process known as cryptic female choice (CFC). Understanding CFC requires demonstration of a female-driven post mating bias in sperm use and paternity, and a causal link between this bias and male cues. Here, we show that in the vinegar fly *Drosophila melanogaster,* mated females eject the ejaculate of their first mate faster when exposed to the pheromones of an attractive male than in the presence of an unattractive one. Using transgenic males expressing fluorescent sperm, we show that exposure to attractive males between mating causes twice-mated females to bias sperm storage towards the second male, affecting paternity. Using pheromonal bioassays in combination with genetic manipulation of sensory systems, we show that females modulate ejaculate ejection latency in response to male pheromones heptanal and 11-cis-Vaccenyl acetate (cVA) sensed via olfactory receptor neurons OR35a, Or22a, Or65a and OR67d, demonstrating that polyandrous females use male pheromonal cues to modulate ejaculate ejection timing. We provide the first demonstration to our knowledge of a CFC mechanism allowing a female to increase or decrease the share of paternity of her first mate depending on the sensing of the quality of potential mates in her environment. These findings showcase that

paternity can be influenced by events that go beyond copulation and highlights the importance of post-copulatory sexual selection.

S35-6 The organization of the antennal lobe in the clonal raider ant

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Human neurobiology has evolved to support social cognition, cooperation and communication. These phenomena are broadly important for normal social interactions in humans and other highly social animals, yet we know little of their cellular foundation in the brain. For eusocial insects, like ants, the chemosensory system is the gateway to communication. Ants share information encoded in large arrays of pheromones which are received and processed by highly advanced olfactory systems among insects. My research uses state-of-the-art neurogenetic tools to study the cellular basis of chemical communication in the nervous system of the clonal raider ant (*Ooceraea biroi*). These ants engage in complex social behaviors not displayed by conventional model organisms, yet the experimental accessibility of the clonal raider ant provides a powerful platform for mechanistic neuroscience studies.

Peripheral olfactory sensory neurons (OSNs) are necessary for pheromone perception and the production of normal social behaviors in ants. These cells project axons to a central olfactory processing area called the antennal lobe (AL) where they coalesce into globular structures called olfactory glomeruli and form a topographic map for the representation of the chemosensory environment. With approximately 500 olfactory glomeruli, the clonal raider ant AL is more complex than many other insects and is even evocative of the olfactory bulb in the brain of mammals (*Drosophila* have ~50 AL glomeruli, for reference). Here, I use transgenic clonal raider ants and imaging approaches to shine light on how AL organization is adapted as a key processing center for communication in this organism.

S36-1 Palatability and the Importance of Sensory Cues and Eating Pleasure in Promoting Healthy Dietary Patterns

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In a complex connection between sensory perception and dietary preferences, sensory cues such as taste, aroma texture and appearance influence eating behaviors and are important in determining food liking and hedonic eating experiences. Food sensory properties are central in shaping ‘what’, ‘how much’ and ‘why’ we eat and influence the learning that drives our dietary patterns to influence health. Not all calories are created equal, and food texture, taste, and aroma direct food choices, inform our eating behaviours and through this influence meal size. Sensory preferences are learned through experience with factors such as sensory-specific satiety, flavor-nutrient conditioning, and food reward associative conditioning, which drives food choice and intake behaviours. The term “hyperpalatability” developed to refer to foods with high levels of fat-sugar, fat-sodium, or carbohydrate-sodium, has been proposed to heightened brain reward and stimulate over-consumption. However, this nutrient-based definition fails to capture the subjective emotional response consumers experience when consuming a palatable food. There exists no evidence for an elevated hedonic or reward response to a food sensory property, above what is already known for the role of palatability after intake. This session will present an overview of what is known about sensory based food reward, the role of food palatability on food intake, will summarize the role of taste exposure in the development of food preference and dietary patterns, and will propose

approaches for the design of effective dietary interventions for promoting healthier eating habits and improving public health outcomes.

S36-2 What is liking? Understanding the Role of Liking and Wanting in Food Reward

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When referring to food, the English word palatable means ‘pleasant to the mouth’. A shorter word for palatability or taste pleasantness is liking. In our model of food reward, liking and wanting act independently to determine food reward, which we define as the momentary value of a food to the eater/consumer. There is not a direct measure of wanting, as wanting, in contrast to liking, is not experienced consciously as separate from food reward. Instead, we quantify wanting as food reward minus liking. Supporting our model, we find that hunger (via wanting) affects food reward (measured by desire to eat ratings) without affecting liking (measured by taste pleasantness ratings). Sensory-specific satiety, which is a decrease in reward value of a food eaten in the meal compared with non-eaten foods, comprises a reduction in both liking and wanting. Food disgust reduces wanting but not liking. Liking for the sensory characteristics of foods is influenced by innate biases (e.g., liking for sweetness), and acquired through individual experience via taste-to-postingestive consequence learning. It is therefore challenging to predict liking from food composition alone. For example, when we applied our validated measures to compare ultra-processed foods (claimed to be ‘made to be hyperpalatable’) versus non-ultra-processed foods as defined by the NOVA metric, we found no significant difference in liking. Similarly, we found no significant difference in liking between foods defined as hyperpalatable foods versus non-hyperpalatable foods according to a nutrient clustering metric. That is, neither of these metrics reliably identifies hyperpalatable foods.

S37-1 Utilizing olfactory receptor defined glomeruli to understand the transformation of odor representations in the mammalian olfactory bulb

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An essential component of olfactory encoding in the olfactory bulb (OB) is the transformation of signals from input (olfactory sensory neurons: OSNs) to output (mitral/tufted cells: MT cells). However, signal transformation from OSNs to MT cells has only been delineated in a single class II receptor. Functional characterization of additional olfactory receptors (ORs) is needed at both the pre- and post-synaptic levels of processing to delineate general principles of signal transformation in the OB. To address this, we generated four mouse lines expressing mKate2 in the OSNs of a given OR, including two class I and two class II receptors. We then used two-photon imaging in awake, head fixed mice expressing genetically encoded calcium or glutamate reporters in MT cells to characterize the selectivity of OR-tagged glomeruli and map the transformation of odor information along the OSN-MT neuronal circuit. Each OR-tagged glomerulus was probed with a large panel of 30-50 odorants, chosen based on in vitro response data and in vivo activity dependent changes in pS6 expression, to delineate pre- and post-synaptic tuning. Presynaptic glutamatergic input as well as MT cell calcium responses were far more narrowly tuned than OR responses in vitro. We also found that MT cell tuning closely mimics that of presynaptic,

glutamatergic, input onto the MT cells, with the important exception that MT cells of certain ORs exhibit stereotyped suppression that is not present in the input. This suggests the presence of lateral inhibition that is odorant-specific and stereotyped across individuals for a given OR.

S37-2 The role of insulin in the regeneration of the olfactory epithelium and in shaping odorant responses

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Diabetes disturbs glucose metabolism and a changed metabolic status can alter odor perception. Furthermore, insulin is involved in neural growth and survival. However it remains unclear how diabetes, in particular type-1, changes regeneration of the olfactory epithelium (OE), neural activity and the odor response properties of olfactory receptor neurons (ORNs). Using a drug-induced type-1 diabetic mouse model, we will describe how hypoinsulinemia slows the recovery of the OE following injury and that insulin and its receptor are required during a specific time window to aid regeneration. Nasally-applied insulin can mitigate these changes.

We used electro-olfactogram (EOG) recordings to examine how diabetes alters odorant responses at the level of the entire OE. Testing six odorants, EOG responses increased for three and remained similar for the others, while for one odorant, response termination also occurred faster. Using single cell techniques to record from individual ORNs expressing known odorant receptors (ORs) showed that ORNs from diabetic mice that express the I7 OR had a significant reduction of basal activity when compared to control, but those expressing the mOR-EG OR, which already have a low basal activity, did not. For ligand-evoked responses, the maximal current responses of ORNs expressing mOR-EG or I7 OR were not different between control and diabetic mice. But responses of I7 ORNs in diabetic mice decayed much more rapidly, while those of mOR-EG ORNs did not. These results suggest that type-1 diabetes can alter odorant perception beginning in the periphery and that changes in ORN activity are OR-dependent.

S37-3 Decoding spontaneous activity patterns for olfactory receptor-specific glomerular segregation

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The formation of precise sensory maps depends on the ordered projection of neurons, a process that is initially dictated by genetic programming and later fine-tuned through neural activity-dependent mechanisms. In the field of developmental neuroscience, numerous studies have suggested that correlated neural activity drives sensory map refinement according to the Hebbian synaptic plasticity mechanism. In contrast, spontaneous activity in the primary olfactory system has been reported to lack spatiotemporal correlation, which contradicts the predictions of Hebb's theory. In mice, Individual olfactory sensory neurons express only one functional olfactory receptor (OR) gene, and axons from olfactory neurons expressing a given OR converge onto a specific pair of glomeruli at stereotyped locations in the olfactory bulb. It has been shown that ORs regulate various kinds of cell adhesion molecules to generate the combinatorial molecular code for olfactory circuit formation. We have previously found that olfactory

sensory neurons exhibited subtype-specific temporal patterns of spontaneous activities that induced specific expression patterns of axon-sorting molecules for axon convergence. Our recent finding implies a novel form of activity-dependent mechanism in which cell-intrinsic patterned activity regulates gene expression programs for circuit refinement. I will discuss how neural activity is involved in OR-dependent circuit formation.

S37-4 Molecular Control of Developmental Critical Period and Imprinted Odor Memory

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Animals have an innate ability to recognize certain odors and respond with stereotypical behaviors. This ability is thought to be genetically hardwired. We found that odor exposure during the critical period of olfactory system development can convert innately aversive odors into a homing signal. The newly gained response is impervious to perturbation by experience or associative learning, indicating that this type of odor memory is imprinted. This conversion is associated with changes in the projection patterns of olfactory sensory neurons (OSNs). We found that the Wnt receptor Frizzled1 (Fzd1) is a master regulator of the developmental critical period that enables odor imprinting. Fzd1 controls an activity-driven regulon in the OSNs and exhibits an autoregulated shutdown. The transient expression of Fzd1 leads to the downregulation of the regulon, which irreversibly closes the critical period to lock in circuits established during the critical period. Loss of Fzd1 in the OSNs prevents the closure of critical period and abolishes odor imprinting. Our study uncovers a form of behavioral imprinting established during the early postnatal period that has a lifelong impact on nest recognition, and possibly other social attachment.

S38-1 A chemical signal in human female tears lowers aggression in males.

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Rodent tears contain social chemosignals with diverse effects, including blocking male aggression. Human tears also contain a chemosignal that lowers male testosterone, but its behavioral significance was unclear. Because reduced testosterone is associated with reduced aggression, we tested the hypothesis that human tears act like rodent tears to block male aggression. Using a standard behavioral paradigm, we found that sniffing emotional tears with no odor percept reduced human male aggression by 43.7%. To probe the peripheral brain substrates of this effect, we applied tears to 62 human olfactory receptors in vitro. We identified 4 receptors that responded in a dose-dependent manner to this stimulus. Finally, to probe the central brain substrates of this effect, we repeated the experiment concurrent with functional brain imaging. We found that sniffing tears increased functional connectivity between the neural substrates of olfaction and aggression, reducing overall levels of neural activity in the latter. Taken together, our results imply that like in rodents, a human tear-bound chemosignal lowers male aggression, a mechanism that likely relies on the structural and functional overlap in the brain substrates of olfaction

and aggression. We suggest that tears are a mammalian-wide mechanism that provides a chemical blanket protecting against aggression.

S38-2 An Olfaction-Based Tool for Detection of Consciousness

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How can one know if a brain-injured patient is conscious? And if unconscious, will the patient regain consciousness? Leveraging the unique interaction between olfaction and consciousness, we developed a novel approach to assessing consciousness in brain-injured patients. We designed a non-verbal, indirect method for consciousness detection and prediction of consciousness recovery based on the sniff response – a nasal airflow modulation in accordance with odor properties. We demonstrated [1] that if an unresponsive patient had a sniff response, this assured future regaining of consciousness and predicted long-term survival rates at the single-patient level. Here, we took this technology forward by combining a simple, portable, automated respiratory-based tool for consciousness evaluation at the bedside. We developed a portable nasal respiration device controlled by a custom-made mobile application that instructs the experimenter to deliver odors in a regime tailored specifically to each patient. We tested this technology in four clinical centers in Israel, France, Italy, and Germany. In Israel alone we collected data from 45 brain-injured patients in 197 sessions where we effectively predicted transitions. Twelve patients transitioned between VS/UWS and MSC, 20 remained unconscious, while 13 were in MCS or improved to EMCS during the study. This suggests that olfactory sniffing can be used as a biomarker for consciousness and provide an accessible and much-needed bedside tool that signals consciousness in brain-injured patients.

[1] Arzi A et al. Olfactory sniffing signals consciousness in unresponsive patients with brain injuries. Nature. 2020 May;581(7809):428-433. Doi: 10.1038/s41586-020-2245-5. Epub 2020 Apr 29. PMID: 32461641.

S38-3 Effects of androstadienone on prosocial learning: a double-blind, placebo-controlled study

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Androsta-4,16,-dien-3-one (androstadienone), a putative human sex pheromone, has been reported to affect emotions and social behaviors. The current study takes a step further to examine whether it modulates prosocial behavior and its learning mechanism using a probabilistic learning task. In a double-blind, placebo-controlled, within-subject design, 45 heterosexual females and 38 heterosexual males were exposed to androstadienone and a control solution over two separate days in a counterbalanced order (interval: 7.08±0.86 days). On each day, participants performed a prosocial learning task. In the task, they were asked to learn to gain rewards for three different recipient conditions (self, other, and no one) by choosing symbols associated with potential rewards. A trial-by-trial analysis using a generalized linear mixed model revealed significant learning trends in all recipient conditions of both treatments. Hierarchical Bayesian reinforcement learning modeling demonstrated that exposure to androstadienone reduced learning rate under “self” and “no one” conditions but not under the “other” condition. More importantly, when exposed to androstadienone, “other”-related learning rates were higher than when exposed to placebo: androstadienone was found to lead to less pro-self learning in female participants and less discrimination between “other” and “no one” in both genders. These findings indicate that androstadienone functions as a social chemosignal, influencing prosocial learning mechanisms, thereby substantiating its social effects.

S38-4 Unveiling disease: Discriminating healthy and diseased body odors

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Human body odors (BO) carry information about health conditions, and they are influenced by the disease itself, sweat production, and other factors. Detecting diseases through body odor raises the prospect of monitoring health status. In this study, we employed a multimodal approach to differentiate between body odors from healthy and diseased individuals.

We gathered axillary sweat samples from patients with Parkinson’s disease (PD; *n*=19), mild-cognitive impairment (*n*=10), COVID-19 (*n*=29), and common cold (*n*=9). Healthy controls, matched for gender and age within each disease group, yielded *n*=63 BO samples. These samples underwent analysis using three methods: (1) assessment by female human raters with normal olfactory perception, (2) evaluation with electronic noses for olfactory fingerprints, and (3) analysis via GCxGC-MS to identify body odor compounds. Human raters experienced BO samples twice—once naively and once after training to familiarize themselves with the specific odors.

Preliminary analysis in PD patients and controls revealed that 79% of human raters correctly identified PD BO as “diseased” after training when presented with the other Bos. These odors were characterized by descriptors such as intense, unpleasant, sweaty, musty, strong, and foul. Furthermore, analysis using electronic noses and GCxGC-MS revealed distinct clustering patterns between BO from PD patients and their healthy counterparts.

In conclusion, our study demonstrates that BO from individuals with PD exhibit discernible characteristics that distinguish them from those of healthy individuals.

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S38-5 Whole brain multivariate pattern analysis of olfactory representations

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Neuroimaging studies of human olfaction show an involvement of primary and secondary olfactory cortices. However little is known about odor processing further downstream. Moreover, it is largely debated whether the human olfactory system is organized as a set of domain specific regions that code for certain odor categories such as food or body odors or whether it contains separable modules for attributes such as pleasantness or intensity. We argue that our limited knowledge is at least partially due to the still predominant mass-univariate approach in olfactory functional magnetic resonance imaging.

We presented 10 odorants in a quick event related, condition-rich and breathing guided design using an MRI compatible olfactometer (Cynexo) while measuring participants' brain responses with a BOLD sensitive accelerated high-resolution protocol on a 3T Siemens Prisma scanner. We estimated the participant's brain responses on a whole brain level and submitted these 'activation maps' to a whole brain multivariate searchlight analysis using 10-fold crossvalidation and linear discriminant analysis. The resulting group-performance maps showed above chance odor-classification in piriform cortices, anterior olfactory nuclei and the amygdalae, but also further downstream in parietal cortex.

We will discuss a set of multivariate approaches from multivariate pattern classification to representational similarity analysis that allow investigating on the level of the whole brain, whether a brain area can distinguish odorants or classes of odorants and whether it reflects similarities between neural and behavioral representations. Such representational approaches have a tremendous potential for further uncovering how chemical differences eventually yield brain based perceptual impressions and judgements.

S38-6 Is there a male body-odor associated with unexplained recurrent pregnancy loss (uRPL)?

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In the Bruce effect, pregnant mice miscarry following exposure to bodily odors (BO) emitted from a male stranger. Bruce-like effects have been implicated in other mammals, and in our previous study (Rozenkrantz et al, eLife, 2020), we found that women who experienced uRPL displayed altered perceptual and brain responses to men's BO, suggesting a possible link between uRPL and the olfactory

system. We now sought to examine whether uRPL-men and control-men emit different BO. We collected Bos from spouses of uRPL and control women (T-shirts worn for two consecutive nights). Twenty-one women with uRPL and 24 controls sniffed 34 BO (17 uRPL-men, not spouses) and rated them on a visual analogue scale. We found that uRPL-men's BO was rated as more pleasant, sexually attractive, and fertile than controls' (rmANOVAs for each parameter but intensity revealed a significant effect of men BO type (all $p<0.001$), no women-group effect or interaction). Fifty-one nulliparous women (not related to the study) performed the same task, and the results were replicated (pleasantness, sexual attraction and fertility: all $p<0.006$, intensity: $p=0.38$). We then used an electronic nose (Airsense) to sample 37 male Bos (18 uRPL). Based on this data, a Linear SVM classifier successfully classified the odors to uRPL or control-men at 69.9% accuracy in a five-fold cross-validation test ($p<0.001$, estimated by repeating the process 1000 times and shuffling the labels). These initial results suggest that uRPL and control-men's BO have different chemical composition, which further strengthen the possible link between uRPL and the olfactory system.

S39-1 Olfaction under the lens of a computational microscope

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During your visit to Iceland, you may have had the opportunity to taste surströmming and discover its very distinct aroma. You might have been surprised that Icelanders enjoy this strong fermented fish and wondered what could be the origin of the discrepancy in appreciation of this dish?

To answer this question, and more generally to determine the influence of polymorphism in olfaction, we are studying how receptors expressed on the surface of the sensory neurons are activated by odorants. Our work shows that it is possible to predict agonist-induced activation of odorant receptors.[1] Numerical simulations identify the functional molecular switches that encode agonist detection and downstream signalling mechanisms within chemical receptors.[2]

By applying a combination of numerical and experimental approaches, we have revealed how mutations in specific residues affect the activation dynamics of trace-associated amine receptors, leading to a different perception of fish odour.

[1] M. Hladiš, M. Lalis, S. Fiorucci, & J. Topin. Matching receptor to odorant with protein language and graph neural networks. *The Eleventh International Conference on Learning Representations,* **2023**.

[2] C. A. de March‡, J. Topin‡, E. Bruguera, G. Novikov, K. Ikegami, H. Matsunami, J. Golebiowski, Odorant Receptor 7D4 Activation Dynamics, *Angewandte Chemie International Edition*, **2018**, Apr 16;57(17): 4554-4558. DOI: 10.1002/anie.201713065

S39-2 Bio-benchmarking electronic olfaction: Decoding complex odour stimuli with near-millisecond precision

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Olfaction plays a paramount role in survival and behaviour for many animals. To be successful, brief and intermittent encounters with scent packages that originate from turbulent dispersion processes need to be rapidly detected and recognised. While organisms like fruit flies, moths, and mice exhibit remarkable odour recognition capabilities within milliseconds, artificial olfaction technologies have faced challenges in achieving comparable temporal resolution. Existing solutions are slow, bulky, expensive, or power-intensive; limiting their applicability in real-world scenarios. In this paper, we introduce and carefully evaluate a miniaturised and high-speed electronic nose system based on metal-oxide (Mox) sensors. The system allows for high-bandwidth sensor readouts, as well as for rapid and precise control of the sensor hotplate. By evaluating the system using a high-fidelity odour delivery setup, we showcase its capability to accurately classify near-millisecond odour pulses. Further, we demonstrate successful temporal feature discrimination of stimuli switching with up to 60 Hz, matching and exceeding the performance observed in mice in similar tasks. The timescales in which the presented system resolves odour fluctuations are unprecedented in miniaturised low-power settings. For the first time, it is possible to match the temporal resolution of animal olfaction in robotic systems. This achievement paves the way for addressing numerous challenges in environmental monitoring, disaster management, and security.

S39-3 Toward Next-Generation E-Nose Systems: Bio-Inspired Deep Learning for Olfactory Mixtures and Concentration Analysis

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This study presents a cutting-edge electronic nose (e-nose) system enhanced by deep learning, designed to significantly improve artificial olfaction. Traditional e-noses, which emulate human olfactory functions, identify and analyze gases and chemical substances, benefiting sectors such as health, safety, and environmental monitoring. Current applications encompass food quality assessment, environmental pollutant detection, and disease diagnosis via breath analysis. However, to emulate the human olfactory system’s ability to discern a diverse range of odors, e-noses necessitate further technological enhancements.

Our novel architecture combines long short-term memory (LSTM), convolutional neural networks (CNNs), and fully connected layers, reflecting the structures of the olfactory epithelium, olfactory bulb, and brain, respectively. This system is engineered to classify accurately both the components and concentrations of complex odor mixtures. Our evaluation on eight distinct olfactory molecules, tested both singly and in combinations, demonstrated an accuracy exceeding 93% in classifying mixed gases and determining three concentration levels. Additionally, the system effectively distinguished ten different wine types with over 92% accuracy. An analysis on sensor optimization indicated that while a higher number of sensors typically increases accuracy, optimal configurations can achieve superior precision with fewer sensors.

This research addresses pivotal challenges in e-nose technology, such as the detection of a broad range of odors, and the classification of mixture components and concentrations, markedly advancing e-nose efficacy. The proposed system offers promising applications across various industries, including healthcare and virtual reality, representing a significant step forward in the development of next-generation e-nose technologies.

S39-4 The processing of odor mixtures in the human brain varies depending on the quantity of odorants present in the mixture

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Most odors encountered in daily life are mixtures containing multiple odorants. Odor mixtures differ from single odorants, not only in the number of odorants but also in odor perception. Odor mixtures can be perceived either as individual elements, where each component is discernible, or as configurations, where single odorants blend to create a new unified odor. The mechanisms underlying how the human brain processes odor mixtures in relation to perception remain unclear. Previous studies on odor mixtures have indicated that as the number of single odorants in the mixtures increases, the perception tends to be more configurational. This study aims to explore how the human brain processes odor mixtures based on the number of odorants by analyzing behavioral responses and brain activity using electroencephalography (EEG) measurements. The findings reveal that in binary mixtures, individual odorants are discernible, whereas in ternary or quaternary mixtures, they are not. Through EEG and machine learning analysis, it is suggested that the human brain may process odor information related to the number of odorants in a mixture from an early stage. This research contributes to our understanding of how the brain handles odor mixtures.

S39-5 Encoding Odor: Bridging Smell and Combinatorial code using M2OR database

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The digitization of olfaction represents a formidable challenge, bridging chemical, biological, and computational sciences to replicate the complexity of smell perception. Addressing this interdisciplinary challenge, we introduce the M2OR, a database featuring 75,050 experimental measurements across 1,257 olfactory receptor (OR) sequences from 11 species. This database is meticulously curated to ensure accurate molecular representation, including isomer differentiation critical for olfactory recognition. The detailed annotation of OR-molecule interactions emphasizes the variability in recognition spectra caused by small amino acid changes, which underlines the necessity for exact sequence documentation in olfactory research.

Investigation of this database allowed to define an intrinsic property, the range of activation, i.e. broadness which appears to be conserved for each family of OR. This metric also facilitates the development of a naïve model to establish a benchmark for evaluating future OR-molecule machine learning models. Analysis of the distribution of the effective concentration (EC_{50}), as well as the distribution of the molecule tested in the chemical space offers a useful tool for future OR-molecule exploration.

The M2OR database marks a significant advance In the quest to digitize olfaction, offering a robust foundation for developing predictive models that can navigate the nuanced landscape of smell perception. By providing a comprehensive and curated dataset, M2OR not only facilitates immediate research applications but also sets the stage for future innovations in olfactory digitization.

S40-1 Odour imagery ability is linked to food craving, intake, and adiposity change in humans

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Central neural circuits integrate signals from the external and internal world to optimize ingestive behavior. These signals are experienced consciously (e.g., the smell of a bakery) or subliminally (e.g., activation of the vagus nerve during lipid digestion) in “real time”; but they can also be experienced off-line. For example, the smell of the bakery may lead to future simulations, such as imagining eating a favorite pastry, which could in turn promote food intake by providing information about the value of a potential future action. Data will be presented from psychophysical and neuroimaging studies in healthy humans showing that the fidelity between real and imagined odor coding in the primary olfactory cortex correlates with objective perceptual measures of odor imagery ability. These neural and perceptual markers of imagery ability are in turn associated with self-reported craving generated during encounters with palatable food cues and with cue-potentiated feeding. Collectively, the work establishes a role for primary olfactory cortex in supporting the generation of images of desire which promote food intake.

S40-2 Gut-Brain Pathways for Reward and Aversion

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Neural connections linking the gastrointestinal tract to the brain and increasingly recognized as a conveyor of motivational signals. On one hand, lower gut segments contain cells sensitive to anorectic peptides that activate brain centers related to avoidance. This is the case for example enteric neurons are sensitive to the endogenous factor GLP-1, which triggers gastric distension and consequent food rejection. On the other hand upper segments including the duodenum, and the adjoining portal-mesenteric vein, are innervated by fibers that transmit reward signals. These observations suggest a role for intestinal and portal tissues in decision-making related to food ingestion.

S40-3 A reduction in gut microbiome evenness and diversity may mediate changes in metabolism regulated by the olfactory system and perturbed by fatty diet

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Use of isocaloric feeding paradigms and genetically-modified mouse lines (MC4R-/- and Kv1.3-/-) have demonstrated that consumption of excess fat in the diet (32.5 to 60% kcal/fat) rather than a change in adiposity causes structural loss of olfactory sensory neurons and their projections, as well as functional sensory deficits. To investigate a relationship between olfactory function and whole-body metabolism, we engineered mice with enhanced excitability of mitral and tufted cells (M/TCs) of the olfactory bulb. To increase neuronal excitability, we used Tbx21-Cre x flox-Cas9 progeny and retro-orbitally delivered a sgRNA directed to cleave the Kv1.3 channel in M/TCs. When challenged with a 25-week moderately high-fat diet, CRISPR males demonstrated improved health metrics over control littermates. They were

resistant to weight gain, had faster glucose clearance, had reduced serum leptin and liver triglycerides, and preferentially metabolized fats as fuel. In control mice, we found that the moderately high-fat diet, whether provided *ad libitum* or isocalorically-matched to control food, resulted in significantly elevated serum TNFα and gut microbiome dysbiosis. Fecal samples were processed for 16s V3-V4 sequencing, and fat-feeding induced an elevated *Firmicutes* to *Bacteroidetes* ratio, elevated *Actinobacteria*, and reduced diversity and evenness. At the family level, changes in *Erysipelotrichaceae*, *Bifidobacteriaceae*, *Lachnospiraceae*, and *S24-7* were marked following the fat feeding. Fecal microbiome transplants are underway using antibiotic depletion. Future experiments will examine how the gut bacteria of fat-fed mice may cause detriment to the olfactory system, and test whether this can be mitigated by substitution of CRISPR editing.

S40-4 GLP-1 as a Signalling Molecule underlying Modulation of Sensory Learning and Perception

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Survival under selective pressure depends on the ability of our brain to use sensory information to our advantage to control physiological needs. To that end, neural circuits integrate external environmental cues and internal metabolic signals to form learned sensory associations, which consequently motivate our behaviour.

In the talk, I will discuss how the brain senses, integrates and prioritizes metabolic and external signals to initiate appropriate behavioural and physiological responses. Here, specifically, I will consider behavioural adaptation related to peripheral metabolic mediators, such as glucagon-like peptide 1 (GLP-1). To that end, I will demonstrate that sensory learning and the motivational effect of hunger are reduced when metabolic sensing is impaired in obesity, as indexed by reduced insulin sensitivity. GLP-1 agonists normalise both impaired learning about sensory associations and the reduced motivational effect. Collectively, these findings reveal that GLP-1 receptor activation modulates sensory learning and, consequently, motivated behaviour, showing metabolic signals can act as neuromodulators to adapt our behaviour to an interoceptive state.

S41-1 Emerging endotypes of chronic COVID19 chemosensory dysfunction through transcriptional and mediator characterization

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Chemosensory dysfunction (CSD) persists beyond 6 months in 2-4% of patients recovered from COVID19, accounting for over 4 million people in the US alone. To define the mechanistic correlates and characteristics of chronic COVID19 CSD, we recruited study subjects (n=73) with COVID19 CSD and controls with no history of COVID19 CSD (n=21) at the time of enrollment. All subjects underwent objective evaluations of smell (UPSIT) and taste (B-WETT) acuity. Nasal cells and fluid were collected with self-applied Floqswabs and nasosorption strips, respectively. Among study subjects with chronic COVID19 CSD (24±5 months), UPSIT(23±7) and BWETT(16±4) were significantly reduced compared with controls (UPSIT33±4, $p<0.001$; BWETT19±3, $p<0.01$). Three endotypes of COVID19 CSD emerged: dysosmia (UPSIT≤25, B-WETT≥17), dysgeusia (UPSIT ≥26, BWETT ≤16), and combined dysosmia and

dysgeusia (≤25, ≤16). All COVID19 CSD subjects had significantly increased nasal swab immune cells (53%) compared with normosmic controls (28%, p=0.02). Flow cytometric analysis indicated that the infiltrating immune cells were predominantly macrophages and neutrophils. Transcriptionally, subjects with dysosmia without dysgeusia had a differentially increased signature of myeloid derived suppressor cells. In subjects with dysgeusia or dysgeusia and dysosmia, several linoleic acid metabolites were significantly elevated and negatively correlated with BWETT scores: 9- and 13-HODE, r(64)= -0.4 p<0.01, 12,13di-HOME, r(64)= -0.5, p=0.001. An imprint of dysregulated myeloid immune signature emerges for COVID19 dysosmia, while eicosanoid dysregulation marks and differentiates the dysgeusia endotype. Chronic COVID19 CSD is a multifactorial syndrome with distinct endotypes.

S41-2 A Glomerular Hierarchy for Olfactory Discriminations

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Can we predict the perceptual similarity of two odorants from knowing which odorant receptors (oRs) they activate? This seemingly simple question remains unsolved as difficulties in controlling stimuli at the level of receptor types preclude disentangling their individual contribution in shaping olfactory perception.

To overcome this limitation, we exploited the anatomical clustering of oRs to individual glomeruli and identified them in transgenic mice using two-photon and widefield imaging. After determining their responses to 123 odorants, we created synthetic olfactory stimuli by optogenetically activating combinations of glomeruli with sub-glomerular resolution. To determine perceptual distances between glomerular sets, we asked mice to report differences in stimulus identity and quantified the contribution of each glomerulus in shaping stimulus perception.

Our psychophysical model revealed a striking glomerular perceptual hierarchy: some glomeruli were up to six times more potent than others in creating a reference percept. We further investigated whether this hierarchy is rooted in the glomerular (oRs) odor response spectra. Indeed, we found a significant correlation between the perceptual weight of each glomerulus and the average similarity of its odor response spectrum to the spectra of other glomeruli in the pattern. Alternatively stated, the more a glomerulus odor response spectrum resembles those of other glomeruli, the lower its perceptual weight.

Our work contributes to elucidating how the brain maps differences in odorant receptor activation patterns to distinct olfactory percepts. The unifying framework we propose bridges the gap between the biophysical features of sensory input units and the structure of the perceptual space.

S41-3 Visualizing the human olfactory projection in a deformable 3D reconstruction assembled by deep learning and high-performance computing

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Visualizing in humans the 3D microanatomy of the axonal projections of olfactory sensory neurons from the olfactory epithelium to the olfactory bulb together with the ancillary structures of bone and vasculature necessitates a workflow for handling a great many sections, and the image registration will be computationally expensive. Here, we assembled a 3D reconstruction starting from a 7.45 cm3 *en-bloc* specimen that we extracted from an embalmed human cadaver. A complete series of 10 µm coronal sections was subjected to quadruple fluorescence histology and scanned in four channels. Structures of interest were manually segmented in the scanned images. Convolutional neural networks were then trained for automatic segmentation of these structures. A high-performance computing solution was engineered to register the sections based on the fluorescence signal and structures segmented. The 3D reconstruction offers several didactic capabilities. We arrived at an approximation of the number of olfactory sensory neurons in human: 2,690,273.

S41-4 Structural elucidation and molecular mechanisms of mammalian odorant receptors

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Odor perception is based on odorant receptors (oRs), which belong to the large family of G protein-coupled receptors and more particularly to the rhodopsin-like family, also called class A. The vast majority of odorant receptors show poor cell surface expression in non-olfactory cells due to retention of the endoplasmic reticulum (ER), hindering their structural elucidation and functional study. Here, we study at the molecular level the expression mechanisms of this sub-family of G protein-coupled receptors. In this project, we use the diversity of the odorant receptor repertoire to create new optimized synthetic receptors based on their consensus sequences. Using these consensus oRs cases, we study the role of amino acids in their expression through molecular modeling, site-directed mutagenesis, and flow cytometry. Their functionality is also assessed by *in vitro* assays. We then developed a protocol to produce and purify the most promising oRs which allowed us to obtain the first structural elucidations of a mammalian OR. This research is crucial, not only to understand the strategy of our brain to perceive its olfactory environment but also to identify general mechanisms governing the function of oRs.

S41-5 Impaired pheromone perception and abnormal sexual behavior in ancV1R deficient female mice

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AncV1R, a putative vomeronasal receptor, is highly conserved across a wide range of vertebrates and is expressed in the majority of vomeronasal sensory neurons, co-expressing with canonical vomeronasal receptors, V1Rs and V2Rs. The pseudogenization of ancV1R is closely associated with VNO degeneration, indicating its critical role in pheromone detection. However, the specific role of ancV1R remains unknown. In this study, to elucidate the function of ancV1R, we conducted phenotypic analyses using ancV1R-deficient female mice. Physiological analyses demonstrate that the loss of ancV1R function reduced VNO response to various pheromone sources, including male urine, pups, and the sexual enhancing pheromone ESP1. Behavioral analyses showed that ancV1R-deficient females displayed no preference for male urine over female urine and exhibited rejective responses toward male sexual behavior. Pre-exposure to ESP1 did not overcome the rejection behavior caused by ancV1R-deficiency. Analysis of neural activity in the vomeronasal system revealed increased responses in the medial amygdala and posteromedial cortical amygdala of mutant females upon contact with males, but not in response to male urine alone. Additionally, there was increased neural activity in the lateral septum, a stress-related brain regions, along with elevated stress hormone levels in ancV1R-deficient females upon male contacts, but not in females exposed solely to male urine. These findings suggest that ancV1R facilities VNO response to pheromone stimuli, plays a crucial role in recognizing males as mating partners in females, and its absence results in failure of male recognition leading to abnormal sexual behaviors and stress responses upon male contact.

S41-6 Characterization of the Human Olfactory and Vomeronasal System During Fetal Development: A Morphological and Immunohistochemical Study

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Our understanding of the human vomeronasal system is limit ed by a lack of systematic studies. Despite the undisputed presence of the vomeronasal organ (VNO) in fetal development, its microscopic characteristics, neurochemical properties, and glycoconjugate expression have not been thoroughly explored. Similarly, information on the development of the olfactory mucosa and the main olfactory bulb remains scarce. Here we focus on the morphological and functional characterization of the human olfactory and vomeronasal system during fetal development. We employed 11 fetal samples from both sexes, ranging from 6 weeks to the perinatal period. Olfactory bulbs were extracted, and along with the nasal cavities, were fixed in Boui''s solution or 10% formalin. After decalcification of the latter in EDTA, all samples were embedded in paraffin and serially sectioned in the transverse plane. Routine histological stains were performed, as well as immunohistochemical techniques with antibodies against G proteins, calcium-binding proteins, and against various components of the olfactory subsystems, as well as a panel of lectins.

Our preliminary findings include the presence from the earliest stage (6 weeks), of a tubular duct in the base of the nasal septum, indicative of the VNO, and the characterization of immunohistochemical and histochemical labeling patterns of the VNO and the olfactory mucosa throughout development. Our immunohistochemical examination of the olfactory bulb reveal a structural and functional complexity during fetal development.

This study provides a foundation for understanding the development of the human olfactory and vomeronasal system, paving the way for future research on function and clinical relevance.

S42-1 Functional dependence of insular-piriform coupling during chemosensory processing.

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Thomas Gray [1]

[1] Brandeis University, Waltham, United States“"Flavor”" the term used to describe perception of taste-smell compound stimuli, more broadly refers to the complex interactions between multiple systems involved in deciding whether a substance in the mouth is worth consuming. This process is experienced by the organism as taste, and is therefore typically thought of as reflecting the influence of olfaction (and vision, etc) on taste perception. We have shown, however, a roughly reciprocal involvement of primary gustatory (insular) cortex (GC) in the perceptual processing of odors, and have gone on to demonstrate that this involvement is specific to retronasal olfactory processing—GC impacts perception of an odor when a rat is specifically involved in making a consumption-related decision regarding a substance in the mouth, and not when the rat is engaged in orthonasal olfaction. Here, we present an investigation of the neural substrate of this result, showing that GC and primary olfactory (piriform) cortex (PC) couple into a processing unit for purposes of processing chemosensory cues. The nature and degree of this coupling proves to depend both on the specifics of the stimuli and on the relation of the task to consumption. We conclude by considering possible explanations for how a single olfactory stimulus can activate different circuits in different contexts.

S42-2 Taste-induced ‘olfiction’: transfer of taste properties to odor via selective, illusory odor enhancement

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The interplay between taste and smell has been a topic of interest for many years, as these two senses work together to create the perception of flavor. Taste is thought to provide additional sensory information to odor perception, helping to disambiguate and enhance the perception of odors. To test the role of congruent taste improves odor identification, we presented odor-taste pairs varying in congruence: congruent (orange with sour, chicken with savory), incongruent (orange with savory, chicken with sour) or intermediary (orange-chicken with savor or sour). In Experiment 1 (N=21), taste compared to water enhanced odor intensity. Odor identity, rated on a scale ranging from orange to chicken, shifted toward the odor congruent with the taste suggesting a transfer of taste properties to the odor. To test whether taste-induced odor suppression or enhancement caused the shift in odor identity, we measured the intensity of each odor component separately in Experiment 2 (N=21). Odor intensity was most enhanced by a congruent taste without evidence for suppression of incompatible combinations. Odor-enhancement was strongest when the to-be-rated odor was not presented suggesting a taste-induced illusory percept. These findings underscore the integrative nature of sensory processing and suggest that congruent gustatory cues can refine our olfactory perception and induce illusory percepts. The results bear implications for enhancing food flavor perception and designing more effective olfactory interventions.

S42-3 Mechanisms of mechanotransduction and texture perception in lingual neurons

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We use the sense of touch to guide essential oral functions, including nutritional assessment, feeding, and speaking. Our recent work has characterized the anatomical and physiological properties of oral mechanosensory neurons, and we found that tongue-innervating mechanosensory neurons are anatomically distinct and possess force-response relationships that are unique compared to canonical mechanosensory neurons. Using in vivo calcium imaging and unbiased clustering, we classified trigeminal tongue-innervating mechanosensory neurons based on force-response relationships. We knocked out the principal mechanosensory ion channel Piezo2 in a subpopulation of tongue-innervating neurons and found that this resulted in fewer rapidly inactivating mechanically activated whole-cell currents, but slow and intermediately inactivating currents remained. This suggests the presence of Piezo2-independent modes of mechanotransduction in this population of neurons. Next, we tested whether the loss of Piezo2 resulted in a loss of force-induced tongue-innervating trigeminal responses in vivo using calcium imaging to determine whether Piezo2-independent mechanotransduction could result in physiologically meaningful alterations in neuronal activity. Conditional Piezo2 knockout reduced the fraction of stroke-sensitive neurons while introducing neurons with sustained responses to pressure. Collectively, this suggests that Piezo2 is necessary for stroke sensitivity, but other mechanosensory ion channels are utilized to transduce pressure in tongue-innervating neurons. Our current work is aimed at determining the roles of Piezo2 in lingual texture detection and transduction of flavor compounds.

S42-4 Oral somatosensation and taste engage a shared neural representation in the brain

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Central gustatory neurons have been mostly investigated for processing only taste information. Existing data indicates these neurons can also respond to oral somatosensory signals. It is intriguing to know where and how these two sensations intersect in the brain, which may reflect the role of taste-active cells dually responsive to other modalities. In this talk, I am going to present some of our recent data exploring the integrative neural processing of oral somatosensation and taste in the parabrachial nucleus (PbN). This work has partly used genetic-assisted neural control techniques and extracellular recordings from PbN neurons in mice to map circuits supporting taste-integrative responses. PbN taste neurons can be excited by activation of upstream trigeminal circuits originating from an oral somatosensory region of the trigeminal nucleus caudalis (Vc), implicating them in orofacial nociceptive and thermosensory processing. Furthermore, a subpopulation of bitter taste-sensitive cells in the PbN was identified to co-fire to aversive trigeminal stimuli (capsaicin and noxious heat). Nociceptive, but not taste, activity in PbN bitter taste neurons was suppressed by photoinhibition of Vc circuits, implying convergent trigeminal input contributes to somatosensory responses. Along this line, optogenetic excitation of TRPV1-lineage fibers that supply sensory input to Vc neurons was found to elicit responses in integrative, bitter taste PbN neurons that were sensitive to capsaicin and noxious heat. Overall, these results provide evidence of multisensory convergence between gustatory and somatosensory representations, reflecting a broader functional role for somatosensory-active taste neurons in protective processing.

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S43-1 Top-down modulation of olfactory information processing in mice

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Sensory information uptake and processing are among the central tasks of the brain. Sensory input is shuttled through several brain areas that all heavily process and modulate this information to adapt it to the anima''s needs. State-dependent adaptations are mediated predominantly through top-down inputs. The most prominent olfactory cortex (OC) regions the anterior olfactory nucleus (AON) and the anterior piriform cortex (APC) receive direct olfactory information from the olfactory bulb (OB) and in turn influence OB processing through strong cortical top-down projections. However, we know very little about the function of these centers in relation to each other. We therefore directly compared these centers in terms of input and odor representation.

To investigate sensory inputs to OC, we separated OB output neurons, mitral and tufted cells, depending on their innervation area. Two-photon calcium imaging in the OB revealed distinct properties of AON and APC projecting tufted cells in terms of odorant tuning and concentration coding while responses of mitral cells were more similar to each other.

Using multielectrode recordings in awake animals we investigated odor representation in AON and APC respectively. Similar to what has been shown for APC, AON neurons display a marked dichotomy of excitatory or inhibitory responses. AON neurons showed a higher excitation-to-inhibition ratio and a low but significant number of bidirectionally concentration-modulated units not detectable in APC. Inter-trial variability was higher in AON and was, in contrast to APC, not reduced by sensory input. A detailed investigation is crucial for an understanding of top-down modulation processes.

S43-2 State-dependent modulation of odor valence and social behavior via the main olfactory pathway

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Mammalian social behaviors such as aggression are influenced by conspecific chemical cues, typically low volatility molecules that activate the vomeronasal pathway. While the main olfactory system is required for proper social behaviors, the molecular basis for how social cues are detected via the main olfactory pathway of mammals is not well-characterized. Trimethylamine is a volatile, sex-specific chemical that is enriched in adult male mouse urine and specifically activates main olfactory sensory neurons that express trace amine-associated receptor 5 (TAAR5). Here we show that trimethylamine, acting via TAAR5, elicits state-dependent attraction or aversion in male and female mice depending on neuroendocrine or social status. Genetic knockout of TAAR5 abolishes valence responses in both sexes and significantly reduces aggression-related behaviors in males, while adding trimethylamine augments aggressive behavior towards juvenile males. We further show that transgenic expression of TAAR5 specifically in olfactory sensory neurons rescues aggressive behaviors in knockout mice, despite extensive remapping of TAAR5 projections to the olfactory bulb. Our results show that state-dependent

behavioral responses to a volatile social cue are mediated via the main olfactory pathway, identify a specific main olfactory input (TAAR5) as necessary for intermale aggression, and reveal that apparently innate behavioral responses are independent of patterned glomerular input to the olfactory bulb.

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S43-3 Internal state dependent modulation of chemosensory processing in Drosophila melanogaster

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Animals adapt their behavior to meet a variety of internal needs. A vital example is the need to eat and to ingest the appropriate nutrient composition in order to maintain nutrient homeostasis by fulfilling current or anticipated nutrient requirements. Hunger and appetite for specific nutrients are driven by internal states like nutrient and mating states. How internal states act to modulate behavior remains poorly understood.

We use automated feeding and foraging assays to record food choice and foraging parameters from flies in different internal states at high detail. We find that animals adapt foraging decisions and nutrient specific food intake depending on their mating and nutritional status and that behavioral changes are driven by modulations of taste and odor processing.

Using a variety of behavioral, molecular and physiological measurements, we find that sensorimotor processing is modulated across different neuronal levels. Volumetric 2-photon imaging approaches revealed that protein deprivation, which drives protein specific appetite, alters nutrient specific processing of taste information across large parts of the subesophageal zone, the first taste processing center in the *Drosophila* brain. Mating state, despite also driving protein appetite, has a more focused effect on regions related to feeding motor output. In the olfactory system, we find that deprivation of any single essential amino acid triggers transcriptional changes in sensory neurons (ORN), facilitating the detection of commensal bacteria.

Our work shows that internal states orchestrate multifaceted modulations, encompassing transcriptional regulation, neuronal processing, and motor output, to fine-tune chemosensory information processing and guide adaptive behaviors in *Drosophila*.

S43-4 Role of the hypothalamus in odor processing

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Smell is one of the most important sensory cues for predicting food and is likely to play a key role in food choice and consumption. The olfactory bulb is highly modulated by nutritional status via the endocrine system (Palouzier-Paulignan et al, 2012). However, we still do not know how the brain region that has a major control on food intake and energy expenditure–- the hypothalamus–- affects olfactory activity and olfactory-guided feeding behaviour.

We investigated the influence of AgRP neuron of the arcuate nucleus of the hypothalamus on olfactory processing. We combined behavioural testing and in vivo calcium recording of granule cells using fibre photometry in two mouse models in which the activity of AgRP neurons was manipulated.

First, in AgRP DTR mice, perinatal ablation of AgRP neurons was achieved by toxin injection in the first week after birth (Luquet et al., 2005). Second, we used chemogenetic transient activation of AgRP neurons in AgRP-cre animals. Our data show that manipulation of AgRP neuron activity affects olfactory behaviour and granule cell activity independently of nutritional status. The data suggest that, in addition to endocrine regulation, the activity of hypothalamic AgRP neurons is involved in olfactory behavior and processing at the level of the olfactory bulb.

S43-5 Heartbeat-induced modulation of rat olfactory bulb neuronal activity via mechanosensitive ion channels

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Heartbeat transmission through the cerebral vascular system is known to cause intracranial pressure pulsations. Here we show for the first time that arterial pressure pulsations can directly modulate neuronal activity within the central nervous system via baroreceptive transduction. We recorded local-field-potentials (LFP) within the rat olfactory bulb (OB) using a semi-intact, perfused nose-brain preparation, while monitoring the pressure pulsations induced by the peristaltic perfusion pump that in our setup operated within the physiological range of heartbeat-induced pulsations. We found slow LFP oscillations that matched the pump-induced pulsations, originated from the vicinity of the mitral cell layer and were sensitive to hypoxia, yet insensitive to blockade of neuronal spiking. Cationic fast mechanoreceptors, most likely Piezo2 channels that were recently found in mitral cells, play a crucial role in transducing this baroreceptive response: The spider venom D-GsMTx4, a TRPC/Piezo channel blocker, abolished the LFP oscillations, but preserved the spike rate and the basal LFP activity. Moreover, the waveform of the slow LFP oscillations derived from the observed spectral harmonics was best explained by Piezo2 gating properties. LFP oscillations also entrained spontaneous mitral cell spikes. In-vivo parallel multi-electrode and heartbeat recordings (n=19 animals) confirmed that a subset of OB neurons synchronized their spiking to heartbeat within 20 ms, independently of the presence of nasal respiration (n=6). Similar heartbeat entrainment was also observed in the hippocampus and prefrontal cortex. We propose that a network of interoceptive ‘heartbeat sentinel neurons’ can modulate perception thresholds, e.g. within the context of arousal.

S44-1 The Universal Urine Machine

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Controlled and ethologically faithful stimulus presentation to animals with a functional vomeronasal system is a challenge, since investigation of other individuals or their secretions often involves contact. The lack of such a method hampers a quantitative analysis of behavioral abilities and underlying neuronal

mechanisms. To overcome this gap, we developed an instrument that allows contact-based stimulus delivery to awake head fixed mice as they perform perceptual odor tasks. After describing our instrument, I will show results from recent behavioral experiments addressing detection and discrimination of social cues in mice.

S44-2 Sensory coding and experience-dependent plasticity in the accessory olfactory bulb

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Many rodent social behaviors are strongly influenced by chemical signals and are widely considered to be innate and hardwired. However, behaviors such as male-male aggression are also highly experience-dependent, modulated by factors such as social isolation and dominance relationships between specific individuals.

To probe the cellular basis for experience-dependent changes in aggression, we used *ex vivo* whole-cell recordings of mitral cells in the accessory olfactory bulb (AOB), which transmit sensory information to limbic centers. Mitral cells from submissive animals showed a marked loss of intrinsic membrane excitability that reduced their ability to maintain firing over behavioral timescales. Parallel work in females showed similarly reduced excitability in the subset of mitral cells engaged during mating, suggesting that experience selectively modulates the coupling between specific sensory input channels and downstream effector circuits.

These data suggest that adaptive changes in sensory responsiveness contribute to behavioral changes, but little is known about AOB dynamics during natural social encounters. We used miniscope imaging to visualize AOB activity during active investigation of conspecifics, probing the encoding of the full suite of natural cues present on social partners. While investigation activates a considerable fraction of AOB glomeruli, only a relatively small subset show strong selectivity for sex or strain. Interestingly, the strength and timing of AOB responses can vary widely across sensory contacts, and aggressive behavior is not readily predicted by the immediate history of AOB activity. Together, these combined cellular and *in vivo* imaging approaches should help illuminate how AOB influences ongoing social behaviors.

S44-3 Recognition of Predator Threat Through the Vomeronasal Organ in Mice

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Animals have the innate ability to select optimal defensive behaviors with an appropriate intensity in response to predator threats in specific contexts. Innate defensive behaviors are thought to be computed within the specific neural circuit including the medial hypothalamic nuclei that contain neural populations controlling defensive behavior patterns. The vomeronasal organ (VNO) detects predator cues and sends ascending signals to the medial hypothalamic nuclei, especially to the ventromedial hypothalamus (VMH), via the medial amygdala and bed nucleus of the stria terminalis. We therefore hypothesize that predator signals detected by the VNO are processed in the VMH, triggering appropriate defensive behaviors in rodents. Our research aims to elucidate the VNO-derived sensory circuitries that regulate defensive behaviors against predators. I will discuss our recent findings regarding the sensation of imminence of predator threat through the VNO in mice. Our results provide a framework for understanding molecular

and neural mechanisms underlying the decision making process of innate defensive behaviors against predator threats.

S44-4 On the scent of chemosensory landscapes: analysis of ligand binding by large receptor families

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Olfaction and taste provide organisms with chemosensory information through ligand binding and receptor activation. The pattern of activation across receptors and ligands is foundational for sensory perception, while also representing biology's largest playground for studying such interactions. This presentation will describe our initial efforts to tackle this problem at scale, directed at weaving together computationally-generated receptor structures with experimentally-observed patterns of ligand-receptor activation. Olfactory receptors, vomeronasal type 1 receptors, and taste type 2 receptors exhibit striking differences in the composition of their predicted orthosteric sites, and these differences are leveraged to make testable predictions about ligand affinity.

S44-5 Pheromones on tap: VNO sensation in freely moving mice

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The sense of smell in the mouse largely occurs through the *main* olfactory system (MOS) which has the amazing ability to detect trace amounts of an infinite variety of volatile organic ligands. With this sensory power why does the mouse, and most terrestrial vertebrates, also have a vomeronasal organ (VNO)? While there has been tremendous progress characterizing the molecular and cellular features of the VNO, we cannot predict when or how a population of vomeronasal organ neurons (VNO) responds in any natural environment. Current approaches to study the system are constrained to either observe behavior while blind to neural activity or sacrifice behavioral function to study neural activity ex-vivo. We are now leveraging head-mounted mini-scope imaging as a simple approach to study neural activity of VNO glomeruli in the accessory olfactory bulb. This strategy is illuminating features of the neural code (dynamics, identity, and variability) of freely moving, natural sensing behavior during investigation of a variety of monomolecular and ethologically relevant intact odor sources. Miniscope imaging is enabling efficient study of the majority of VNO activity as the individual naturally approaches, interacts with, and triggers a dynamic repertoire of innate actions. We aim to create a rich dataset to identify the basic rules of the relationship between behavior and neural activity to more accurately model, predict, test, and understand how sensation drives action.

S45-1 A systematic review of 50 years of olfactory working memory studies

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Some working memory (WM) processes is hypothesized to generalize across the type of sensory memoranda; an examination of WM in olfaction could test this idea. We evaluated human olfactory WM studies published over the last 50 years (N=42), and attempted to find evidence for 21 recently proposed "benchmarks" for WM. Of the 9 benchmarks that were well assessed with odor stimuli, 7 generalized to olfaction, while the other 2 failed to generalize from verbal stimuli to odorants. Evidence was insufficient for the remaining benchmarks (4 had mixed support, and 8 are as yet unaddressed). Thus, when it could be observed, WM benchmarks usually generalize to olfactory WM, suggesting a WM system that has capacities that resemble those of other senses. We argue that researchers studying WM should explicitly consider chemosensory evidence when establishing theoretical frameworks, and suggest that many WM benchmarks provide fruitful avenues for future olfactory research.

S45-2 Behavioral and Cortical Effects of Olfactory Working Memory Training in Older Adults

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Training on working memory (WM) tasks for older adults has predominantly shown improvements on the trained tasks or similar ones, which would not mitigate general cognitive decline. However, past interventions primarily used visual stimuli, rarely engaging the olfactory system. In this ongoing study we investigate the effect of an odor-based WM training intervention on older adults' cognitive abilities. Thirty-nine healthy older adults (aged 65-75) were randomly assigned to either an olfactory training or a visual training group, each undergoing 20 sessions of 45-minute training on an adaptive spatial WM task, along with cognitive assessments and fMRI before and after the intervention. Initial findings show that participants retain fewer items in WM in the olfactory version of the task and a comparatively slower rate of improvement on the training task in the olfactory group. Additionally, results regarding cognitive performance transfer effects, task-based and resting-state fMRI activity will be presented from both groups before and after the intervention.

S45-3 Is working memory performance for odors highly correlated with that for visual and auditory stimuli?

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A common assumption in theories of higher cognitive processes is that they are transmodal, operating similarly regardless of sensory stimuli. In an ongoing data collection, healthy young adult participants were tested for olfactory, visual and auditory WM abilities, using similar experimental protocols, to test whether they would be highly correlated. Thus far, 11 of 40 participants were tested. Sniffin' Sticks TDI was used to control for varying olfactory acuity among participants, whom all reported normal eyesight and hearing. There were no significant unadjusted correlations between olfactory WM and visual WM (r=0.24) or auditory WM (r=0.24). When olfactory scores were adjusted for TDI, correlations involving

olfactory WM became significant with both auditory (r=0.44) and visual (r=0.51) WM. The correlations remained lower than the auditory-visual WM correlation (r=0.85). Olfactory WM may rely in part on a transmodal WM process but sensory performance differences may obscure similarities at the cognitive level.

S45-4 The capacity and organization of gustatory working memory

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Remembering a particular taste is crucial in food intake and associative learning. We investigated whether taste can be dynamically encoded, maintained, and retrieved on short time scales consistent with working memory (WM). We use novel single and multi-item taste recognition tasks to show that a single taste can be reliably recognized despite repeated oro-sensory interference suggesting active and resilient maintenance (Experiment 1, N = 21). When multiple tastes were presented (Experiment 2, N = 20), the resolution with which these were maintained depended on their serial position, and recognition was reliable for up to three tastes suggesting a limited capacity of gustatory WM. Lastly, stimulus similarity impaired recognition with increasing set size, which seemed to mask the awareness of capacity limitations. Together, the results advocate a hybrid model of gustatory WM with a limited number of slots where items are stored with varying precision.

S46-1 Specialization in the gustatory system of bees

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The gustatory system plays a crucial role in feeding preferences. Previous studies have focused on the gustatory coding mechanisms in flies, showing that specific receptor proteins respond to nutritionally valuable or toxic substances, enabling the encoding of information in separate channels which regulate feeding reflexes but not discrimination within sweet or bitter categories. The logic of taste in flies, however, is not entirely shared in bees. Our research aims to elucidate the gustatory mechanisms that underlie dietary specialization in bees, extending the understanding of taste coding beyond the well-studied model of flies. We have investigated the gustatory response of three bee species to monomolecular sugars and sugar mixtures mimicking floral nectar. Contrary to flies, where taste perception is largely binary (sweet versus bitter), we found that bees possess a nuanced ability to discriminate among sugars, suggesting a more complex gustatory system. Specifically, our findings reveal that the gustatory system in bees relies on temporal spike patterns of gustatory neurons to encode information about the nutritional value of sugars. This enables bees to classify sugars and sugar mixtures, forming a perceptual map of floral nectars at the gustatory periphery. Our data suggest that the population of gustatory neurons in bees forms a sophisticated coding mechanism that allows for the distinction between different floral nectars, indicating a further specialization in their gustatory system. Our research broadens the understanding of taste coding in insects, revealing complex gustatory mechanisms in bees that support their dietary specialization and foraging preferences.

S46-2 Plant bitter substances render honey bees blind for sugar

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Honeybees (*Apis mellifera*) rely on floral nectar as their main carbohydrate source, displaying a selective foraging behavior by actively choosing the targeted plants. To evaluate the quality of nectar, they perceive sugar through specialized gustatory receptors (Grs). Although this plant-pollinator relationship between honeybees and plants is generally mutualistic, nectar may also contain noxious plant secondary metabolites. This apparent contradiction in plant–pollinator mutualism, i.e., the offering of aversive compounds in addition to attractive rewards, has intrigued ecologists for decades. How honeybees perceive these bitter-tasting compounds has remained unclear. Here we investigated this controversial issue and discovered a novel function of the honeybee sugar receptors AmGr1 and AmGr3. Interestingly, our biophysical studies with AmGr1 or AmGr3 expressing oocytes demonstrate that bitter substances directly target these sugar receptors and inhibit their function in the low µmolar range. Plant bitter substances may therefore not act directly as aversive deterrents for bees but reduce the ability of honeybees to taste sugars through gustatory receptors. Paired choice experiments with free-flying honeybees confirm our biophysical studies and show that the extent of bitter compound-mediated inhibition depends on the substance and its concentration. Finally, our results provide new insights into honeybee bitter taste/sugar perception that influence associative learning and thus play an important role for foraging decisions of bees. It also offers insights into a new role of sugar receptors and their implications in plant-animal interactions with opportunities to develop strategies for ensuring honeybee survival in a sustainable ecosystem.

S46-3 Gustatory coding of feeding sugars in the polyphagous agricultural pest, Helicoverpa armigera

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Almost all herbivorous insects feed on plants and use sugars as feeding stimulants, but the molecular basis of their sugar reception remains unclear. *Helicoverpa armigera* as a notorious crop pest worldwide mainly feeds on reproductive organs of many plant species in the larval stage, and its adult draws nectar. In this study, we determined that the sucrose sensory neurons located in the contact chemosensilla of larval maxillary galeae were 100–1000 times more sensitive to sucrose than those of adult antennae, tarsi and proboscis. Using the *Xenopus* expression system, we discovered that Gr10 highly expressed in the larval sensilla was specifically tuned to sucrose, while Gr6 highly expressed in the adult sensilla responded to fucose, sucrose and fructose. Moreover, using CRISPR/Cas9, we revealed that Gr10 was mainly used by larvae to detect lower sucrose, while Gr6 was primarily used by adults to detect higher sucrose and other saccharides, which results in differences in selectivity and sensitivity between larval and adult sugar sensory neurons. Our results demonstrate the sugar receptors in this moth are evolved to adapt towards the larval and adult foods with different types and amounts of sugar, and fill in a gap in sweet taste of animals.

S46-4 Somatotopic maps of taste appendages in the primary gustatory centre and in the brain of the honey bee Apis mellifera

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Animals attain discrimination between toxic and nutritious substances through the detection of volatile and non-volatile chemicals. In this context, the ultimate arbiter deciding for ingestion or rejection of an item is the brain, through the sense of taste. Studying the pathways of taste neurons from the periphery to the brain may offer valuable insights into the neural mechanisms underlying gustatory processing and animals' foraging strategies, particularly for ecologically relevant species like the honey bee, *Apis mellifera*. Despite intensive studies on other sensory modalities on this model (olfaction and vision), there is currently no integrative study investigating the organization principles of taste pathways in the primary gustatory centre (suboesophageal zone, SEZ) and in the brain of the honey bee. By performing anterograde mass staining with dextran-coupled fluorescent tracers in the main appendages involved in insect gustation (antennae, mouthparts and tarsi), we identified the projection areas of the different sensory afferents in the SEZ. Our results show sensory circuits confined in specific regions of the SEZ, reflecting the anatomical segregation of taste appendages, and suggesting the presence of somatotopic "maps" preserved in gustatory circuits. We also confirm the subesophageal-calycal tract (SCT) as the main output of the SEZ. By performing retrograde staining of the SCT coupled with anterograde staining of taste appendages, we show that SCT dendrites specifically overlap in the SEZ with sensory input from the mouthparts (proboscis). By means of specific staining with calcium-sensitive dyes, we are currently developing preparations to perform optophysiological recordings of the SEZ during gustatory stimulations.

S46-5 The taste of humans and nectar: gustation in the Asian tiger mosquito

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The taste system controls many insect behaviors, but is greatly understudied in mosquitoes. Little is known about how tastants are encoded in mosquitoes or how they regulate critical behaviors. Here we examine how taste stimuli are encoded by the *Aedes albopictus* mosquito, a highly invasive disease vector, and how these cues influence biting, feeding, and egg laying. We find that neurons of the labellum, the major taste organ of the head, differentially encode a wide variety of human and other cues. We identify three functional classes of taste sensilla with an expansive coding capacity. Unexpectedly, in addition to excitatory responses we discover strikingly prevalent inhibitory responses, which are predictive of biting behavior. Certain bitter compounds suppress physiological and behavioral responses to sugar, suggesting their use as potent stop signals against appetitive cues. Complex cues, including human sweat, nectar, and egg-laying site water, elicit distinct response profiles from the neuronal repertoire. We identify key tastants on human skin and in sweat that synergistically promote biting behaviors. Transcriptomic profiling identifies taste receptors that might be targeted to disrupt behaviors. Our study sheds light on key features of the taste system that suggest new ways of manipulating chemosensory function and controlling mosquito vectors.

P001 Olfaction Evaluation in Dogs with Sudden Acquired Retinal Degeneration Syndrome (SARDS)

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Purpose. To evaluate olfaction in dogs with sudden acquired retinal degeneration syndrome (SARDS) compared to sighted dogs and blind dogs without SARDS as control groups. Methods. Olfactory testing was performed on three groups: SARDS, sighted, and blind/non-SARDS using eugenol as test odorant. The olfactory threshold was determined when subjects indicated detection of a specific eugenol concentration with behavioral responses. Olfactory threshold, age, body weight, and environmental room factors were compared among groups. Results: Sixteen SARDS dogs, 12 sighted dogs, and 12 blind/non-SARDS dogs demonstrated mean olfactory threshold pen numbers of 2.8 (SD=1.4), 13.8 (SD=1.4), and 13.4 (SD=1.1), respectively, which correspond to actual mean concentrations of 0.017 g/mL, 1.7*10-13g/mL and 4.26*10-13 g/mL in the SARDS dogs, sighted dogs, and blind/non-SARDS dogs, respectively. Dogs with SARDS had significantly poorer olfactory threshold scores compared to the two control groups ($p<0.001$). Age, weight, and room environment did not differ among the three groups. Conclusions: Dogs with SARDS have severely decreased olfaction capabilities compared to healthy, sighted dogs and blind/non-SARDS dogs. This finding supports the general principle that SARDS is a systemic disease causing blindness, endocrinopathy, and hyposmia. Since the molecular pathways are similar in photoreceptors, olfactory receptors, and hormone synthesis with all using G-protein coupled receptors in the cell membrane, the cause of SARDS may exist at the G-protein associated interactions with intracellular cyclic nucleotides. Further investigations into G-protein coupled receptors pathway and canine olfactory receptor genes in SARDS patients may be valuable in revealing the cause of SARDS.

P002 Can fragranced cosmetic influence well-being and self-confidence of the user? Is it perceived by the close and broader circle of the user?

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Introduction

Nowadays, more and more people assess mental and physical stress with impact of their self-confidence and well-being. Cosmetic users expect their cosmetics bring more than skin benefits. In parallel, aromatherapy improves well-being, relaxation… but does not act on skin efficacy. Nevertheless, only few studies show how a proven active fragrance* on emotions can increase also skin benefits. The main objective is to see how fragrance cosmetic use can bring skin and emotional benefits to the user and how this can also be perceived by their close and broader social circle.

Materials and methods

65 active European & Chinese women, 25 to 45 y.o, premium skincare users, without olfactory disorders, are included into the study. Women have identified a beloved as close social circle representative. An external person, as broader social circle representative, is also included into the study. Each woman uses 3 face creams of the same formula: one with the proven active fragrance*(127), one with the standard

fragrance (271) and one with no fragrance (712). Women use daily, each cream, for one week, and fill daily Self-Assessment Manikin questionnaire (SAM). Before the study and after one week use, women evaluate their emotional states with: SGWB: Scales of General Well-Being, RSE: Rosenberg Self-Esteem, GEW: Geneva Emotion Wheel. For the broader social circle, an external person conducts a recorded video interview.

Results & Conclusion

An active fragranced skincare use increases skin benefits and provides well-being and self-confidence. The results analysis in China allows the selection of culturally differentiating criteria.

P003 Comparative Evaluation of SCENTinel and SST-12 for Assessing Olfactory Function in Italian Adults

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Rapid and accessible assessment tools are essential for promptly identifying individuals with olfactory disorders. Here, we evaluate the efficacy of SCENTinel – a direct measure of odor detection, intensity and identification – in discerning between normal olfactory function and olfactory disorders in a sample of 373 Italian adults. Participants also completed the Sniffin' Sticks Screening 12 Test (SST-12) for identification. Participants self-reported normal olfactory function (*n*=291), COVID-19-related anosmia (*n*=30) or hyposmia (*n*=52). A significantly higher proportion of normosmic participants met the overall accuracy criteria for SCENTinel (94%) compared to anosmic (43%) and hyposmic individuals (75%). A similar pattern was observed for the subtests of odor detection (normosmic=95%, anosmic=73%, hyposmic=81%), intensity (normosmic=99%, anosmic=80%, hyposmic=90%) and identification (normosmic=81% and 66%, anosmic=70% and 33%, hyposmic=64% and 42%; first and second attempt, respectively); all corrected chi-squared test *p*-values <0.001. An ANOVA test showed that normosmic participants also scored higher in the SST-12 (10.5±1.2) compared to anosmic (6.2±1.9) and hyposmic individuals (9.3±1.7); all corrected *p*-values <0.001. Furthermore, participants that passed SCENTinel (*n*=332) showed higher SST-12 scores (10.3±1.5) as compared to those who failed it (*n*=41; 7.4±2.2; *p*<0.001). A comparable pattern of SST-12 scores was observed when considering the outcome of first attempt of the SCENTinel identification subtest (10.3±1.5 vs. 9.0±2.3; *p*<0.001). SCENTinel demonstrates promise as an efficient and reliable tool for the rapid assessment of olfactory function in the Italian population, with a demonstrated association with established olfactory screening measures.

P004 Effects of Visual vs. Gustatory Priming Stimuli on Olfactory Processing Investigated via EEG

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Perceptual processes in a natural context are almost exclusively multisensory. This makes it crucial to investigate multisensory interactions in controlled lab environments. This study involves the effects of priming stimuli from two different sensory modalities, gustation and vision, on olfactory processing.

Specifically, integrative processes of olfactory perception will be studied in the presence of congruent or incongruent, taste or visual stimuli (e.g. salty taste or the word ”salt” followed by popcorn odor). Thirty participants are presented an odor while being subjected to a priming stimulus in the form of a taste or a written word and asked if the odor matches the priming stimulus or not. This setup allows collection of reaction time and accuracy data as well as N400 electrocortical activity via EEG during the task. The EEG component of interest is the N400 which is measured by contrasting processing of predicted vs unpredicted stimuli. The hypothesis is that the response-times will be faster, and the N400 cortical responses will be larger, to taste-odor than for visual-odor combinations, because of the close integration between taste and odor systems. Data collection will take place in the spring of 2024.

P005 Olfactory Learning under Predictive Coding

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Predictive coding frameworks propose that the brain is fundamentally predictive, whereby the brain generates predictions about incoming sensory input. When these predictions do not match the inputs, a prediction error is generated, which is then used to update the brain’s predictions to minimize the probability of future errors. In visual and auditory modalities, evidence for predictive coding is widespread. However, in the olfactory system, much less is known about these neural transformations. Previous research suggests that both olfactory predictions and prediction errors are encoded by human olfactory (piriform) cortex (Pcx). Here, we hypothesize that during early learning, when inputs are unpredictable, Pcx is primarily involved in processing prediction errors. As learning progresses and inputs become more predictable, Pcx switches toward a mode of primarily generating olfactory predictions. To test this hypothesis, we developed an olfactory prediction task during which participants learn probabilistic associations between two shapes (circle, square) that consistently predict two odors (isoamyl acetate and Beta-pinene). Consistent with our hypothesis, we find that participants do not yet form these shape-odor associations during early learning (consistent with prediction error); however, as the task progresses, participants are able to learn these associations (consistent with updating of predictions). Overall, this task presents an opportunity to probe the predictive computations in Pcx that contribute to olfactory learning and point toward a broader theory of predictive coding in the human olfactory system.

P006 The Odor Port: A Cost-Effective and Precise Odor Delivery System for Experimental Research

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Traditional odor delivery systems for experimental research in both animals and humans often entail complex and costly olfactometer designs (Hornung and Mozell, 1977; Lowen and Lukas, 2006) or the rudimentary use of odor-containing vials, which compromises precision in timing, odorant switching, and control over critical variables such as proximity to the subject. To address these challenges, we present the“"Odor Port”" a novel device designed to streamline olfactory research. Leveraging advanced capacitive sensing technology, the Odor Port detects the subjec’'s proximity to precisely release odorants,

ensuring a contactless and safe interaction. This breakthrough device offers precise control over experimental parameters, including the exact timing and distance of odorant presentation, facilitated by an automatic system for switching between different odorants. Constructed from readily available and cost-effective materials, the Odor Port comprises a minimalistic design where a diffuser pump directs the odorant through a tube to the port, which then evenly disperses the scent to the subject through sintered glass, ensuring a consistent and homogeneous odor distribution. Its versatile and portable design allows the Odor Port to be utilized in a wide array of contexts beyond traditional lab settings, offering both precision and convenience for researchers in the field.

P007 Detecting Parkinson's Disease Through Temporal Dynamics of Ongoing Nasal Respiratory Airflow

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There is a profound need for biomarkers in Parkinson's disease (PD). We observe that the sites of earliest brain damage in PD house the neural pace-makers of respiration. We therefore hypothesized that ongoing temporal dynamics of respiration may be altered in PD. We applied a wearable device that precisely logs nasal airflow over time in 28 mostly Stage-II PD patients and matched healthy controls, who each wore the device for 24 hours. We observed significantly altered temporal patterns of nasal airflow in PD, where inhalations were longer and less variable (Duty Cycle Inhale: mean PD=0.3±0.07 (ratio), Control=0.23±0.06 (ratio), z=4.2, effect size Cliff's d=0.63, P=6.9×10^{-5} Bonferroni corrected. Breathing rate variation coefficient: mean PD = 0.26±0.11 (ratio), Control=0.38±0.13 (ratio), z=-4.3, d=-0.64, P=5.3×10^{-5} Bonferroni corrected). Remarkably, the extent of alteration was such that using only 30 minutes of recording we could detect PD at 87% accuracy (testing on participants who were not in the learning set, bootstrapped z=5.7, P=3.5×10^{-9}). Notably, these effects remained even when we restricted analyses to a subset of the cohort with diagnosis within five years or less, implying that these alterations appear early in the disease cascade. Moreover, we could significantly predict disease severity as estimated by Movement Disorder Society–- Unified Parkinson's Disease Rating Scale (MDS-UPDRS) from this same data (Total score: r=0.49; P=0.008). We conclude that the neural drivers of respiration are affected early in the disease cascade, and may provide an indication with diagnostic and prognostic value.

P008 From Nostril to Brain Asymmetry

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In the nasal cycle, nasal airflow is greater in one nostril over the other, an asymmetry that shifts from left to right every ~2.5h. Several observations have suggested links between the nasal cycle and asymmetric brain activity, shifts in autonomic tone, and alterations in cognitive performance, but the nature of these links remains unresolved. To systematically probe these links, 30 participants will engage in a right-hemisphere-associated spatial cognition task, and a left-hemisphere-associated lexical decision task. We will test each participant twice, once during right-nostril dominance, and once during left. We will

simultaneously acquire EEG (64 electrodes, BioSemi-ActiveTwo 2,048 Hz), HRV, and respiration (ADInstruments spirometer 1000Hz). We have currently completed this challenging protocol in one participant (F, Right-handed, age 31). Her mean laterality index (LI), calculated as (FlowR-FlowL)/(FlowR+FlowL), was 0.29 in the right-dominant session, and -0.24 in the left-dominant. This participant failed to understand the spatial cognition task on the first round, so we can analyze the lexical task alone. She was accurate on 85% of trials in left dominance, and 83.75% in right. Moreover, left nostril dominance was associated with increased negativity of the N400 component over bilateral parieto-occipital electrodes, left-dominant = -0.59±3.40 μV; right-dominant = -0.24±1.94 μV; p(FDR) = 0.047. Finally, LF/HF, an HRV measure where higher ratio is associated with sympathetic tone and lower ratio with parasympathetic tone, was 0.85 in the left dominance and 1.16 in the Right nostril dominance. These pilot data are consistent with a right-nostril/sympathetic/right-brain and left-nostril/parasympathetic/left-brain model.

P009 Contrasting neural responses to sweet taste between the sweet-liking phenotypes: an fMRI experiment

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While humans often exhibit an innate attraction to sweet tastes, strong individual differences exist across ages, sexes, and cultures. Recent research, employing more robust statistical techniques, has identified three distinct phenotypic liking patterns for sweet tastes across Europe, North America and Asia: extreme sweet-likers, moderate sweet-likers, and sweet-dislikers. Behavioural and genetic evidence suggests that individual differences between the sweet-liking phenotypes may, in part, be driven by differences in reward processing. However, though research exploring neural responses to sweetness without phenotyping has found activation in reward regions, these often do not control for individual differences in sweet taste liking and have not applied the three-phenotype sweet-liking model. Therefore, we invited forty-eight adults (aged 18-32; 34 females, 14 males), prescreened for sweet-liking phenotype status (25 extreme-sweet likers; 23 sweet-dislikers), to participate in a functional MRI scanning session whilst consuming multiple 1ml samples of 1.0M sucrose and 25mM citric acid solutions. Initial region of interest analyses focused on five regions, separately per hemisphere: two control taste regions (insula and operculum) and three reward regions (orbitofrontal cortex, anterior cingulate cortex, and ventromedial prefrontal cortex). A significant interaction was found between sweet-liking phenotype status and pre-scan liking rating in three reward regions for 1.0M sucrose. Specifically, pre-scan liking was negatively related to activation in the right anterior cingulate cortex and bilaterally in the orbitofrontal cortex for extreme sweet-likers, whereas there was no change in activation for pre-scan liking in sweet-dislikers. Potential explanations for this relationship will be discussed alongside follow-up analyses, including whole-brain results.

P010 Sniffing Colors – Word-Color and Odor-Color Associations of the MONEX-40 test

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Visual stimuli are known to have a strong influence on olfactory perception, a phenomenon called visual dominance. We here aimed to provide a comprehensive color profile, including hue, saturation, and lightness for the standardized MONEX-40 test. Study 1 involved an online survey of 144 participants, assessing the color associated with each descriptor included in the MONEX-40 test. Subsequent color analysis revealed distinct patterns, including clear color schemes, trends, and bivariate or multivariate profiles depending on the specific descriptors. Additionally, queries were posed regarding unknown or challenging descriptors in terms of color assignment, elucidating the significant role of learning in the establishment of word-color associations. In Study 2, color associations for all 40 odors included in the test were evaluated at different time points. Participants first reported color associations based solely on odor perception. Next, the subjects were asked to identify the odor from a choice of four options, mirroring the structure of MONEX-40. Subsequently, participants reassigned colors to the same odors using the previously presented options as cues. Both qualitative and quantitative approaches, including statistical tests and ΔE00 to determine color differences, revealed significant changes in color associations before and after exposure to the respective options. These differences extended beyond hue, encompassing saturation and lightness as well. The knowledge of associated colors to odor descriptors and odors itself serves as a basis for the development of novel odor testing strategies.

P011 Insulin and dopamine receptors modulate “sweet” sensitivity in Drosophila melanogaster

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Hunger can directly modify the sensitivity of food-sensing chemosensory cells as a way to encourage food consumption when nutrients are low. Previous work in *Drosophila melanogaster* demonstrates that gustatory receptor neurons (GRNs) are directly impacted by food deprivation in a way that increases the detection and consumption of sugars. Dopamine plays a role in this process, but potential modulation via canonical hunger/satiety hormones, like insulin, in these gustatory cells has not been described. Using the single-cell transcriptomics database Fly Cell Atlas, we find insulin receptor (*InR*) and dopamine receptor (*DopEcR*) expression in cells identified as “sweet”-sensing GRNs based on the expression of *Gustatory Receptor 64f (Gr64f)*, a sugar receptor. Inactivated insulin signaling only in “sweet”-sensing GRNs via *InR[DN]* expression or *InR*-RNAi knockdown led to increased sucrose sensitivity in the fed state, but not the starved state. *DopEcR* RNAi knockdown resulted in the opposite effect, decreasing sucrose sensitivity, but only in the fed state. *In vivo* calcium imaging of “sweet”-sensing GRNs revealed that sucrose-mediated responses were subtly enhanced without InR signaling in the fed state, matching the behavior. In contrast, overactive insulin signaling via *InR[CA]* expression in “sweet”-sensing GRNs resulted in suppression of sucrose-mediated responses in the starved state. Overall, we conclude that *InR* and *DopEcR* signaling in “sweet”-sensing GRNs reciprocally impacts sucrose sensitivity in a state-dependent manner.

P012 Nasal and oral breathing differently shapes pupillary dynamics

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Even in the absence of odor molecules, ORNs detect mechanical pressure induced by breathing airflow in the nostrils and transmit this information to the olfactory bulb (OB), priming the olfactory system for

potential odor detection. Similarly, it has been proposed that all sensory systems are rhythmically synchronized and enhanced in accordance with the breathing cycle, facilitating an or'anism's readiness to process incoming sensory stimuli. In this study, we investigated how breathing modulates fundamental aspects of visual perception. We focused on pupil dynamics, a critical factor in regulating light intake and maintaining visual focus during task performance. Importantly, pupil dynamics also directly reflects neural dynamics. Participants (n=50) engaged in a resting state task while their pupil dynamics were simultaneously recorded. This procedure was repeated for both nasal and oral breathing conditions. Our findings demonstrate that pupil dynamics exhibit marked variations in response to the breathing phase, with pupil size reaching its peak near exhalation onset and minimum at inhalation onset. Next, we assessed the phase synchronization between breathing and pupil size by calculating the phase-locking value. Permutation testing revealed significant correlation and phase synchronization between these two variables within individuals. Finally, we assessed the chaotic state of the pupil dynamics. In a chaotic state, neural networks undergo continuous reorganization, enabling perpetual flexibility and adaptability. Employing correlation dimension, we demonstrate that nasal breathing enhances the chaotic state in the pupil, suggesting an optimal state. In conclusion, our study shows a direct link between nasal breathing and the first stages of visual perception.

P013 Investigating olfactory disruption upon ozone exposure on D. melanogaster

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Elevated ozone levels present a significant threat to the delicate balance of ecosystems and the biodiversity of insects. Previous studies have indicated that heightened ozone concentrations can disrupt volatile organic compounds, thereby affecting insect foraging and mating behaviors. Furthermore, ozone has been shown to induce changes in insect physiology and their ability to perceive odors. However, the specific influence of ozone on the olfaction of *Drosophila melanogaster* remains unexplored. This knowledge gap motivated us to investigate the effects of ozone on the overall fitness, behavioral performances, and neurophysiological responses of *Drosophila melanogaster*. Our behavioral experiments uncovered a notable decrease in the responsiveness of flies to certain attractive single and complex odors following exposure to ozone, alongside an increased aversion to aversive odors. To delve deeper into the neural mechanisms at play, we employed calcium imaging and electrophysiological techniques, revealing a reduction in neural activity in response to aversive odors post-ozonation. Seeking further insights, we turned to RNA sequencing methods, uncovering subtle yet discernible alterations in gene expression induced by ozone exposure. These findings offer valuable insights into the profound impact of pollutants on insect odor perception and behavior, opening up promising avenues for future research and exploration in this field.

P014 Pairing fiber photometry and video recordings in freely moving animals to better understand the neural basis of olfactory hedonics.

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Fiber photometry offers insight into cell-type-specific activity underlying behavior. In many cases, fiber photometry recordings are performed in response to predictive, time-controlled behavioral paradigms. However, under more ecological conditions, sensory stimuli are unpredictable. In this context, we need to continuously record the 'nimal's behavior and synchronize it with the acquisition of the fiber photometry data. Here, we present a workflow from intracerebral implantation of optical fibers in mice, to the analysis of fiber photometry tracings in relation to the animal behaviors via video recordings. We present the algorithms we developed for synchronizing fiber photometry data with behavior, and scripts for data analyzing. We have highlighted the efficiency of the method by assessing calcium activity and dopaminergic dynamics in the olfactory tubercle of adult C57Bl/6J mice in response to attractive and non-attractive odorants. Using rGeco1a biosensor, we revealed an increase of calcium signaling in response to all odorants, regardless of their hedonic value, while using dLight1.2, we observed an increase of dopamine release in response to attractive but not unattractive odorants. We showed that this change in dopaminergic dynamics in the olfactory tubercle is specific to the investigation of odorants compared to that of non-olfactory stimuli. In conclusion, we provide here a new method that permits automated pairing of fiber photometry data with video recordings to better understand the neural bases of olfactory hedonics in freely moving mice. This method can be applied to other exploratory behaviors.

P015 Advanced genetic tools in D. sechellia uncover central brain re-wiring in its olfactory system

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The comparative study of brain function at the molecular level requires genetic tools in multiple related species. In recent years, we have started to establish *Drosophila sechellia*, a close relative to *D. melanogaster* and *D. simulans* as a neurogenetic model. This species shows several modifications in its olfactory system linked to its specialization on a single host fruit compared to its generalist cousins. However, its low fecundity makes transgenesis challenging. Here, we present a set of novel tools to facilitate the genetic manipulation of *D. sechellia*. We establish several landing sites for site-directed transgenesis and test their functionality for UAS-reporter, Gal4- and splitGal4-driver expression. Transfer of clonal labelling reagents into *D. sechellia* allowed us to perform a systematic analysis of projection neuron morphologies in its olfactory system. Quantitative comparison to *D. melanogaster* led us to identify specific re-wiring of selected olfactory pathways in *D. sechellia* linked to its ecology. In addition, we detected a type of projections neurons with unusual morphology bypassing the mushroom body and directly connecting olfactory input to the lateral horn. These observations support that peripheral receptor changes are accompanied by novel wiring in the central brain to facilitate sensory specialization on a selected host fruit. Overall, we generate a rich resource for transgenic research in this species adaptable to other non-model systems and discover novel cellular architectures in the central brain of *D. sechellia*.

P016 Limbic and prefrontal brain networks represent distinct information about food hedonics and inhibitory control

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Studies of the neural response to food stimuli are often guided by assumptions about the relevance of particular food properties (i.e. taste) and may overlook the properties most relevant to participants. In the present study, we sought to identify those properties and where they are represented in the brain, through analyzing the neuroimaging data of participants who viewed images of 36 types of food during fMRI. We used a clustering approach based on Representational Similarity Analysis (RSA) that partitioned food-responsive brain regions into two networks, based on their multivariate response to those food images: a Prefrontal network of frontoparietal brain regions, and a Limbic network of corticolimbic and sub-cortical regions. We performed RSA within these networks using data from a task involving similarity judgements of those same foods, obtained from a large sample of online participants. We identified that the inferred healthiness of those foods was the greatest factor underlying similarity judgments and this property was most strongly represented within the Prefrontal network, suggesting its involvement in the regulation of food consumption. We confirmed this possibility through analysis of a second neuroimaging task, performed by the same participants, which identified that the response to food images in the Prefrontal network was modulated strongly by judgments of the self-control required to resist eating those foods. In contrast, the Limbic network response was primarily modulated by hedonic food judgments. These results suggest that food-related information is distributed across functionally distinct brain networks which act as opponent processes involved in guiding food-related behavior.

P017 Investigating the Neural Signals Driving the Consummatory Response in Rats

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The gustatory system is an ideal model with which to study the neural processes guiding ethologically-relevant behavior. When a taste stimulus reaches the tongue, the gustatory system has one basic–goal - to determine whether that stimulus should be consumed or expelled from the mouth. Rats produce discriminative orofacial movements reflecting the reaching of this decision. Several labs have investigated neural circuitry leading to the rejection of a tastant, an investigation which is aided by the conspicuous nature of the primary aversive-related orofacial movement, gapes. Here, we aim to better understand the signals guiding and reflecting the decision to ingest a palatable tastant, by developing a machine learning classifier capable of discriminating individual aversive and ingestive-related orofacial movements from electromyographic (EMG) activity of the jaw opener (anterior digastric) muscle. Notably, this classifier successfully identified a distinctive subtype of tongue protrusion, a behavior associated with ingestion, with a similar onset time to gaping. We compared this onset to taste processing in primary gustatory cortex (GC), where taste responses progress through three firing-rate “epochs”. The transition to the late epoch has previously been shown to act as a modulatory signal to initiate gaping, and preliminary results indicate a similar temporal correlation between GC taste dynamics and the decision to ingest. We propose that the late epoch transition guides the selection and initiation of consummatory-related behaviors by modulating brainstem motor circuitry. These findings will ultimately enrich our understanding of how GC sensory information is transformed into appropriate motor responses.

P018 Olfactory thresholds are higher in retronasal olfaction.

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Olfactory loss is a non-motor symptom of Parkinson's disease. This is best known for orthonasal olfaction, while previous studies suggest that retronasal olfaction may be less impaired. This is interesting since retronasal olfaction is the main contributor to flavor perception, and patients with Parkinson's exhibit dietary oddities. However, the difference between orthonasal and retronasal olfactory sensitivity may be due to the different methods used to measure them. A recently introduced method may allow for testing orthonasal and retronasal olfaction with the same material.

The objective of this Itudy is therefore to directly compare ortho- and retronasal olfaction and we hypothesize that there is a difference between them. We aim to assess both ortho- and retronasal olfactory functions in 30 healthy young adults with normosmia with the Yoshino method, by separately measuring olfactory thresholds, the ability to discriminate and identify odors. We apply the same procedure as the *Sniffin'* Sticks test.

Preliminary results from 19 participants (age 30.05 ±2.97 years, 57.9% female) show a correlation between ortho- and retronasal scores for threshold and identification, but not for discrimination. Olfactory thresholds were significantly higher, indicating lower sensitivity, when participants were stimulated retronasally; there was no difference between ortho- and retronasal scores for odor identification and discrimination. Consequently, a combined global olfactory score was significantly higher for orthonasal compared to retronasal testing.

Our data suggests that the Yoshino method can be used to assess orthonasal and retronasal olfaction. We aim to use it for testing olfaction in patient populations such as Parkinson's disease.

P019 Is the anterior olfactory nucleus an intrinsically mechanosensitive relay for olfaction?

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In the mouse olfactory system, mitral and tufted cells in the olfactory bulb receive odor information from the olfactory epithelium and relay this sensory information to the olfactory cortices. Using single molecule Fluorescent in Situ Hybridisation (smFISH) we detected prominent *Piezo2* and *Stoml3* expression in many cells of the olfactory system, but most prominently in the Anterior Olfactory Nucleus (AON). Expression of these two mechanosensory genes was especially prominent in the first two post-natal weeks. Direct physiological evidence for mechanically activated currents in CNS neurons has been limited in the past. Using mice in which *Piezo2-Cre* drives *tdTomato* expression in *Piezo2* expressing cells we found that Piezo2 fate mapped cells were found throughout the olfactory system, most prominently in the AON. We decided to exam"ne t'e AON population physiologically and to do this we were able to establish primary cultures of these neurons. Patch clamp electrophysiological recordings from tdTomato^{+} AON neurons showed that mechanical stimulation either via pressure or substrate deflection was able to generate robust mechanically-activated currents (MA-currents). We thus established a method to isolate and culture primary AON neurons for the first time and we used this model to show that these neurons are mechanosensitive. The mechanosensory gene *Stoml3* has been implicated in odor discrimination ability, but it is unknown if this is due to its function in regulating PIEZO2 channels. We are presently examining whether central mechanosensitivity localized to the AON could play a role in olfaction.

P020 Dissecting odor mixture interactions in the fly brain

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In the natural environment, odors are often blends of many compounds at different concentrations. The focus of this study is to understand how mixtures are encoded in the brain of the vinegar fly, a genetically tractable model system that retains a similar architecture to the mammalian counterpart. In a previous paper, we demonstrated that mixtures of odors having opposing hedonic valances (at certain ratios) are encoded and processed by a mixture-specific activation of projection neurons, the output neurons of the fly antennal lobe (Mohamed et al., NatCommun., 2019). This mixture code is maintained through lateral inhibition in an anisotropic manner initiated between glomeruli encoding opposing odor valences mediated by local interneurons with mostly patchy innervations. The present study aims to achieve a mechanistic understanding of the circuit behind this inhibition. As a first step, we use a genetically encoded voltage sensor to perform two-photon functional imaging of the antennal lobe. We confirm inhibition taking place in the projection neurons, in the presence of an odor of opposing valence. To study this effect at the level of local interneurons, we use a genetically encoded calcium indicator localized at either the presynapse or the postsynapse of diverse local interneuron types, resembling the input and output of these neurons. We find that this pattern of activity mirrors what we would hypothetically expect from an anisotropic neural circuit. Furthermore, we observe that changing the mixture ratio also biases the local interneurons towards a more pre- or post-synaptic disposition.

P021 A novel approach to investigating anticipatory cortical responses to taste associated cues

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Survival is inextricably tied to consumption decisions; ingestion of toxic foods cause illness/death, while nutrient-rich foods promote health. Thus, it is paramount to understand associations between food cues (e.g., the color of a fruit) and post-consumption outcomes (e.g., becoming sick) to guide approach-avoidance decisions. While cue-driven-association research is common, little research focuses on how cue-food associations are linked with palatability preferences. To bridge this gap, we created a novel experimental framework aimed at enhancing learning rates for cue-food reward associations beyond previous studies, within a multi-step response task. This design enables us to separate the effects of a reward's valence from its identity. We designed a paradigm featuring cue-trigger/retrieval-reward sequencing, pairing visual-auditory cues with unique chemosensory food concentrations — palatable sucrose and sodium chloride, and aversive sodium chloride. Behavioral results reveal that rats quickly adapt their approach or avoidance to cues based on reward palatability. As satiation increased during sessions, individual preferences emerged for the palatable options, leading to stratification in total consumption by the 'ession's end. Preliminarily, our behavioral data implicates gustatory cortex (GC) anticipatory activity mirrors taste responses that depend on the individual preferences of the animal (i.e. cue associated with unpalatable tastants evokes an "unpalatable" anticipatory response, and vice-versa for palatable). We will integrate behavioral and electrophysiological data to investigate cue-induced GC activity prior to taste delivery. After learning associati'ns, we'll analyze how the neural encoding of "anticipatory responses" in GC correlates with true taste responses in terms of identity and palatability.

P022 Can odors help us to focus? A multisensory and personalized approach

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Listening to music while concentrating is a widespread practice. Research shows that music and sounds influence diverse types of subjectively and objectively evaluated human cognitive performances. Three main factors are known to contribute to these effects: the task to perform (nature, complexity), individual characteristics (age, etc.), and characteristics of the sensory stimuli (pleasantness, etc.). But is it possible to improve or damage cognitive performances with pleasant or unpleasant odors with or without of music? Is personalization of sensory environments an important factor? To answer these questions, we conducted 4 studies on how odors and music influence executive functioning and subjectively evaluated performances of young and older adults. First, we examined how the olfactory and musical habits of 852 young and older adults differ. Second, we tested the affective correspondences made by 62 young and 49 older adults of several odors and musical excerpts. Finally, we tested the executive functions and subjective performances of 30 young and 30 older adults under 4 conditions of imposed or personalized olfactory and musical environments. Results indicated that subjective performances of young adults are positively influenced by the personalization of olfactory and musical stimulation, pleasant and unpleasant stimuli negatively influenced the response time of the participants, and affective correspondences of multisensory environments significantly influence the objective performances of young and older adults. These results shed light on the intricate interplay of sensory stimuli, cognitive performances, and subjective experiences, emphasizing the potential benefits of personalized sensory environments in enhancing concentration and performance across different age groups.

P023 Bitter taste perception and its neuronal underpinning

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The bitter taste sensation serves as a defense mechanism against harmful compounds, while also contributing to the complexity of culinary experiences and potentially signaling medicinal benefits. It is surprising, however, that both the question of whether bitterness is a unified (monoguesic) or a complex sensation, and its system-level underpinning remain unresolved. Behaviorally, rats showed a complete failure to distinguish between briefly sampled bitterant pairs when intensity is removed as a cue. In humans, while bitterants discrimination is still a difficult task, it was shown that some bitterants can be classified differently from others. Interestingly, the overall-accepted bitterness monoguesic perception hypothesis is at odds with results from neuronal activity studies, mainly from early nodes of the taste system, that showed distinct responses to different bitterants. Here we combined rat behavioral bitterant preference tests with electrophysiological recordings from lower and higher brain regions of the taste system to study the logic of the bitter perception and coding. Our results show that given a longer sampling time (10 minutes), rats significantly preferred denatonium over quinine, and quinine over

sucrose octaacetate (SOA); a preference relation that was maintained across days. Preliminary electrophysiological recording using Neruopixels probes from the gustatory cortex (GC) showed distinct neuronal responses to iso-intense bitter tastes. Our results suggest that bitterness is not as monoguesic perception as was previously suggested, which is probably supported by distinct activation in different regions of the taste system.

P024 Free Fatty Acid Receptors in rainbow trout (Oncorhynchus mykiss): interactions with fatty acids and their metabolites for feeding behavior regulation

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Driven by heightened demand in aquaculture' there's been a shift away from traditional aquafeed ingredients, favoring plant-based alternatives. However, previous research has shown that replacing rainbow trout (RT, *Oncorhynchus mykiss*) diets with plant ingredients, which lack omega-3 long chain polyunsaturated fatty acids (ω-3 LC-PUFAs), from the initial feeding stage, results in reduced growth and survival rates, primarily due to altered feeding behavior.

RT, like mammals, possess mechanisms for nutrient perception, potentially involving the binding of fatty acids on Free Fatty Acid Receptors (FFARs) at the gustatory level. To address this, FFARs in RT were investigated through taste receptor assays using trout FFAR1 and seven paralogs of FFAR2 expressed in HEK-293 cells. We examined various fatty acids and their oxidation metabolites, alongside tongue profiles of trout fed different diets over eight months. Our study revealed high correlation between composition of dietary and trout tongues lipid content with high level of eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) from trout fed a commercial diet, compared to those fed a plant-based diet rich in alpha-linolenic acid (ALA). Intriguingly, we discovered that FFAR1 responded not only to long-chain FAs, similar to mammals, but also to short-chain FAs, a novel finding. Furthermore, multiple FFAR2 paralogs showed sensitivity to short-chain FAs and responded to non-enzymatic lipid oxidation mediators of DHA, a phenomenon not previously observed in fish.

This research aims to deepen understanding of FFARs in fish feeding behavior and their implications for aquaculture practices, facilitating cost-effective and sustainable feed formulations.

P025 Olfactory Alchemy: Unraveling the molecular basis of the Orco-ORx puzzle.

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Olfaction is one of the ancient sensory modalities that insects rely on for survival and to interact with the environment. Insects use different types of receptors to detect airborne chemicals, one of them being olfactory receptors (ORs). In winged insects, a functioning OR signaling complex is likely a heterotetramer comprising of the conserved co-receptor, Orco, and a tuning receptor ORx subunit which provides odorant sensitivity. Recent discoveries shed light on the structural organization of Orco and ORs as

homotetramers, unveiling key interacting domains between different subunits that form this receptor and the ligand binding site. Th" loc'tion of the ligand binding pocket and the interacting amino acid residues that are responsible for the sensitivity of the receptor are known. However, understanding the molecular intricacies governing the formation and assembly of functional complexes between the Orco and ORs remains elusive. Our research aims to address this gap by combining phylogenetic analysis of naturally occurring and divergent Orcos, complex modeling, and functional recordings. Specifically, we are elucidating how a highly conserved Orco assembles and forms functional complexes with multiple divergent ORs. By comparing interactions between Orco and narrowly tuned receptors versus divergently tuned generalist ORs, we also aim to identify differential mechanisms underlying complex formation. Overall, this research will deepen our understanding of the precise molecular interactions between the tryptic formed by Orco-ORx complexes and their ligands.

P026 Decision making in mice using intermittent olfactory stimuli

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Odor cues from distant objects are sparse and highly fluctuating due to turbulent transport. However, whether animals can use these spatiotemporally varying statistics for decision-making is unclear. To address this question, we built a custom olfactometer to deliver discrete and brief (~40 ms halfwidth) odor pulses at arbitrary Poisson-distributed pulse rates. We then developed a behavioral task in which head-restrained, water-restricted mice had to make binary decisions based on the total odor pulse count in 5 seconds to obtain a water reward. Performance in the task approached saturation when mice used total pulse counts far from the decision boundary to make decisions and degraded progressively when rate differences between binary choices diminished. Logistic regression of binary choices against the timing of odor pulses in the breathing cycle revealed that mice weighed sensory information differentially depending on the phase of the breathing cycle in which pulses arrived, a time dependency that correlated with the magnitude of activity in olfactory sensory neurons. *In vivo* recordings from the Anterior Piriform Cortex (APCx) of trained animals revealed that odor pulse presentation triggered stochastic firing across neurons, with only a subpopulation showing dependency on pulse arrival time with respect to the respiratory phase. Moreover, task-related variables could be decoded from APCx population firing. Altogether, our study indicates that mice can integrate intermittent olfactory inputs over several seconds for decision-making, and that the arrival time of olfactory information with respect to breathing cycle modulates its representation across the olfactory pathway, as well as its perceptual weighing.

P027 Congenital blindness on the development and plasticity of the olfactory system : respiration and optical imaging recordings inputs.

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2.2 billion people are visually impaired worldwide. The absence of a sensory modality induces brain plasticity and reorganization of the remaining sensory functions. While this phenomenon has been widely

described in the auditory and tactile domains, the impact of blindness on olfactory functions, and their neurobiological correlates remain poorly studied. In addition, the evolution of this plasticity in blind individuals across development is still poorly known.

The objective of this study is to test the development and plasticity of the olfactory system induced by the absence of the visual system. We chose to address this question in rodents, an animal model that mainly relies on its olfactory sense to perceive and adapt to its environment. Specifically, we used a mouse model of congenital blindness (ZRBDA) where in the same litter half of the conspecifics are born blind and the other half are born sighted. To test the development and plasticity of the olfactory system, we first investigated the mouse olfactory perceptual function using physiological and behavioral measures using a paradigm suitable throughout ontogeny. To do so, we measured the odor-evoked sniffing and behavior at three different ages: (1) in infants (Postnatal day PN10-13, before their eyes opened), (2) in juveniles (PN 30-34, after weaning) and (3) in adults (PN60-62) in both male and female in a whole-body plethysmograph. Second, to assess the underlying neural mechanisms, all of adults were used to map the activity of their olfactory bulb using oItical imaging. Preliminary results will be prIsented in this poster.

P028 Don’t put all eggs into one basket! Oviposition dynamics in a hawkmoth

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Oviposition choice in insects can be influenced by information acquired from visual, olfactory, and gustatory cues. Most studies focusing on oviposition in lepidopterans have examined the insect’s evaluation plant suitability, the resulting subsequent plant acceptance or rejection, and learning from oviposition experience. Especially studies on oviposition learning suggest that experienced moths might exhibit oviposition constancy, i.e. despite naïve moths being generalists, they finally lay most of their eggs on a host they have already experienced. However, whether and how these insects transition between different host species to lay eggs remains poorly explored. Our study investigated the tobacco hawkmoth, *Manduca sexta*, with two well-known hosts (Solanaceae) and a less-studied one (Martyniaceae). When investigating their oviposition behavior in wind-tunnel and semi-natural tent assays, we observed that hawkmoths revisit both individual leaves in the wind tunnel and plant clusters in the tents several times before they search for another host. This revisitation behavior might be mediated by learning, i.e., an immediate increase in preference after experience. At the same time, such behavior is unexpected from an insect optimizing energy. Interestingly, after leaving a cluster of a given host species, we found that moths do not exhibit a higher preference for a second cluster of plants of the same species, suggesting that hawkmoths rather display opportunistic oviposition behavior than oviposition constancy. Host flexibility might be adaptive as it allows the moths to explore and find other suitable hosts for their progeny, and to avoid putting all eggs into one basket.

P029 Engineering Insect Odorant Receptors as a Detection Mechanism for Disease Associated Volatiles

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Odorant receptors (ORs) are highly sensitive chemical receptors that respond to a diverse range of volatile compounds. While organisms relying on olfaction for survival possess remarkable abilities to detect trace chemicals, our current chemical sensing technology is inadequate in comparison. Recent studies have shown significant differences in the chemical profile of human breath between healthy individuals and those infected with pathogens such as malaria, tuberculosis, or COVID-19. Leveraging the unique chemical profiles associated with diseases could provide a robust method for disease detection. In this study, our objective is to engineer insect ORs to selectively activate in the presence of volatiles associated with diseases. Specifically, we focused on MhOR5, an odorant receptor from the Jumping Bristletail (*Machilis hrabei*), a basal insect that lacks the OR co-receptor (Orco) found in modern insects. MhOR5 is a well-characterized receptor with broad selectivity and an experimentally determined structure, making it an ideal candidate for targeted engineering. We expressed MhOR5 in a heterologous cell system using HEK293T cells and tested its response to disease-associated volatiles (DAVs). Through structural analysis, we identified key residues that potentially contribute to ligand selectivity, and tested mutations made at these residues for altered ligand selectivity. Our findings revealed distinct ligand selectivity among most mutants in response to individual DAVs. Additionally, we are developing a platform for high-throughput, non-biased screening of combinatorial mutants. This methodology will establish a solid foundation for engineering ORs with specificity towards particular chemicals and for developing engineered OR arrays for disease diagnosis.

P030 Odor motions and gradients inform Drosophila navigation differently in diffuse and sparse plumes

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Adult *Drosophila* navigates odor plumes using wind direction, local odor concentration gradients, and drifting odor packet motion. After sensing an attractive odor, many animals will orient themselves in the up-wind direction. While wind gives a general source direction, it does not specify crosswind directions; this is aided by odor gradient and motion cues. The effectiveness of these cues can vary as odor dispersal patterns change across different environments. We asked whether these cues differentially predict the crosswind direction to the plume centerline in different plume types and found that local odor gradients guide how freely walking flies turn in diffusive plumes, while odor motion is more informative in sparse plumes. We use data-driven models to identify odor features that upwind-facing flies should calculate to guide their turns. Models trained in the diffusive plume learned to extract concentration gradients, while models trained in the sparse plume learned to extract odor motion. Further, we show that odor motion predicted fly turns in both plume types, but odor gradients only predicted turns in the diffusive plume. Bilateral odor signals inform olfactory navigation in many animals. Our results indicate how this sensory architecture promotes gradient and motion sensing for navigating diverse natural plumes. Additionally, our analysis predicts the behavior of flies: when navigating different plume environments, they use distinct informative cues in each environment. This research advances our understanding of *Drosophila* olfactory navigation and offers analysis relevant to other organisms that must navigate diverse odor environments.

P031 Effects of early olfactory enrichment on brain connectivity and lateralization of the mouse brain.

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Early environmental conditions alter brain connectivity and behavior in adulthood. More specifically, early sensory stimulation is a long-known key modulator of the development of brain connectivity. The specific role of olfactory inputs in the development of functional connectivity within the odor-evoked brain network is currently mostly unknown. We thus aim at deciphering the olfactory performances and brain functional connectivity in post-weaning and young adult (3-month-old) male and female mice enriched with odors from birth to weaning, and compared to non-enriched ones. Using a cross-habituation test, we show that early olfactory enrichment (EOE) improved olfactory discrimination of two closely related odorants in the short and long terms. We revealed the functional connectivity by performing Pearson correlation matrices of odor-evoked c-Fos+ expressing cell densities in 27 regions of both hemispheres distributed in four different functional systems (olfactory, memory, reward, and cortical areas). We first show that brain connectivity is highly asymmetric in response to an olfactory stimulation. We also discovered that, EOE strongly modulated brain connectivity in young adults within and beyond the olfactory areas and that this modulation is asymmetrical. We also showed that olfactory performances as well as functional connectivity are sex-dependent with better olfactory capacities and higher density of connections in females. Studies are on-going for post-weaning animals.

In conclusion, odor-evoked brain connectivity is highly asymmetric in the mouse brain, shows sex-dependent features and EOE is a powerful modulator of brain connectivity and of laterality.

P032 Can the release of facial nerve inhibition on the glossopharyngeal nerve explain metallic taste in head and neck cancer?

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BACKGROUND: Metallic taste is frequent during head and neck cancer treatments but very little is known about its etiologies. One explanation could be the hypothesis of removal of facial nerve inhibition on the glossopharyngeal nerve. Because of the cancer or its treatments, the decrease of taste afferents mediated by the facial nerve (tip of the tongue) would reveal those mediated by the glossopharyngeal nerve (base of the tongue) and thus a metallic taste. We wanted to evaluate the validity of this hypothesis.

METHODS: Selective supraliminar taste tests on the tip and the base of the tongue were regularly performed on 44 patients with head and neck cancers before, during and after their treatment. Sweet, salty, bitter, sour, pure water and metallic tastes were used. Patients were divided in two groups according to the occurrence or not of metallic taste.

RESULTS: 12 patients complained about metallic taste (27.2%), always during the treatment phase. Most of them (83.3%) were treated by surgery and radiotherapy or radiochemotherapy. Supraliminar taste tests results were disturbed in every patient, especially during the treatment phase. The intensity were more significantly reduced in patients with metallic taste for water, salt, sweet and acid tastes, but more on the base of tongue locations than on the tip of the tongue. Metallic taste was significantly linked with mucositis ($p=0.02736$) but neither with candidosis ($p=0.3821$) nor salivary flow ($p=0.6272$).

CONCLUSION: The hypothesis of release of facial nerve inhibition on the glossopharyngeal nerve cannot explain metallic taste in head and neck cancer.

P033 The Nutritional Impact of Metallic Taste in Head and Neck Cancer Patients: Explorations and Clinical Implications

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INTRODUCTION: Metallic taste is frequent during head and neck cancer treatments but very little is known about its impact on nutritional status. We wanted to evaluate the validity of this hypothesis.

METHODS: Questionnaires on quality of life, on metallic taste, weight and an visual analogic scale for food intakes were regularly assessed on 44 patients with head and neck cancers before, during and until one year after their treatment. Patients were divided in two groups according to the occurrence or not of metallic taste.

RESULTS: Metallic taste was common (27.2%), always during the treatment phase mostly linked with radiotherapy or radiochemotherapy. Its intensity was moderate (40%) to high (26.7%). It had a significant negative impact on quality of life linked to dysgeusia (p=0.0252). The negative impacts of metallic taste on the visual analogic scale for food and on weight were not significant, probably because of the small size of the population that had to be followed-up until one year after treatment. Further research in this area could provide additional insights into how to best address these challenges and enhance the quality of care provided to this patient population.

CONCLUSION: Metallic taste arising in 27.2% of the head and neck patients and significantly worsened quality of life linked to dysgeusia.

P034 Host Range Expansion of Eurasian Spruce Bark Beetle, Ips typographus, to Pine

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The Eurasian spruce bark beetle (*Ips typographus*) is one of the most important pests of Eurasian conifer forests, causing serious economic and ecological damage by attacking and killing its primary host tree Norway spruce (*Picea abies*). During recent epidemic outbreaks, *I. typographus* has notably been observed to also attack and kill a secondary host species, Scots pine (*Pinus sylvestris*) besides its primary host. In this comparative study we examined the olfactory preference of the beetle towards the two host species and compared its reproductive performance in spruce versus pine. In behavioral choice assays, no attraction or aversion towards synthetic monoterpenes present in both trees was found. But attraction towards pine bark plugs in both sexes and attraction towards spruce bark plugs in males was shown. Using headspace volatile collection, we observed a similar composition of monoterpenes in the bark of the primary and secondary host but with significant differences in the compound ratios. We further showed that reproductive performance and pheromone emission of *I. typographus* both decreased in

Scots pine, but viable offspring were produced. Still, it is unclear why beetles are attracted towards Scots pine and how they behave in field experiments.

P035 In Vivo Calcium Imaging of Sensory Encoding in Accessory Olfactory Bulb Mitral Cells During Social Interactions

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The accessory olfactory system (AOS) plays a pivotal role in guiding social behavior through the sensing of behaviorally-relevant semiochemicals. It is still uncertain how sensory cues are represented during active social interactions, and how such representations govern behaviors modulated by AOS, including inter-male aggression. Our work directly addresses this gap by using miniature microscopes to record sensory-driven GCaMP6f signals in mitral cells of the accessory olfactory bulb (AOB) during freely-moving and constrained social interactions.

Investigations of social partners differing by sex, background strain, and hormonal status evoke distinct yet often overlapping AOB population responses. These biological traits can be decoded above chance from investigation-evoked population activity. Furthermore, our decoding analyses indicate that conspecific sex is represented across a wide population of AOB units while strain is encoded by a more select subset of units. Such representations may support sex-specific behaviors through a distributed population code within the AOB while still establishing selective pathways to downstream areas.

We find that investigation-evoked activity unfolds across an extended timecourse persisting for tens of seconds following social contact. Sensory-driven activity patterns in AOB are also notably variable across encounters. These dynamics suggest that the AOS integrates sensory information across multiple investigations rather than mapping each individual sampling event onto discrete neural/behavioral responses. Finally, we characterize AOB sensory activity during interactions leading up to inter-male aggression in the resident intruder assay. Our findings collectively shed light on how AOB dynamics during social interactions represent the biological traits of conspecifics and support adaptive social behaviors.

P036 Deciphering chemical communication in an aquatic insect

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Chemical senses (taste and smell) play a key role in the adaptation of species to their environment, especially in insects. Changes in the sensory equipment of insects that have evolved from a terrestrial to an aquatic environment have long aroused the curiosity of scientists, but the mechanisms of sensory perception have never been studied in aquatic insects. This project aims to address this question in the

diving beetle *Rhantus suturalis*, a common species in Western European ponds and an important predator of mosquito larvae.

Chemicals from ecologically relevant sources were identified using physicochemical analyses (GC-MS). Their detection by the beetle's antennae was verified with electro-antennogram (EAG) technique, providing the first insights into the olfactory capacities.

Transcriptomic studies have revealed a significant number of chemosensory receptor families expressed in the sensory organs of *R. suturalis*. Therefore, studying the function of these genes would provide key information on the properties of receptors tuned to specific compounds in aquatic environments. Currently, work is underway to characterize the function of these chemosensory receptors, using heterologous expression in Xenopus oocytes and two-electrode- voltage clamp (TEVC) to finally link these 'eceptors' function to the associated behaviors. This project will provide essential information on prey detection in aquatic insects, which can be transposable to other species for comparative studies. Better assessing the degree of prey selectivity in aquatic beetles can contribute to developing sustainable mosquito biocontrol methods.

P037 Unlocking the genetic code: exploring the intricate relationship between taste perception, food liking, and eating behaviour

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Several factors, including taste perceptions (TP), food liking (FL) and psychology, influence eating behaviour (EB) and, consequently, our health, but genetics also play a fundamental role. However, little is known about the genes involved.

Genome-Wide Association Studies (GWAS) on FL and TP were performed in Italian samples (n=575). Linear regression model analyses were conducted to find the relationship between genetic findings and other parameters of interest.

GW significant association was detected between milk chocolate liking and a region on chromosome 5. The most associated Single Nucleotide Polymorphism (SNP) rs73280705 ($p=1.02x10^{-9}$) was also associated with perceived intensity for sweet and sour taste and with parameters related to behaviour (impulsivity) and with health status (fat mass and visceral fat) ($p<0.05$). Moreover, this SNP is an eQTL for the *LARP1* gene in Nucleus Accumbens (NAc) and the *GEMIN5* gene in adipose subcutaneous and visceral tissues.

Results suggest that this region may play an important role in FL, TP, impulsivity and metabolism. In particular, *LARP1* gene is involved in the mTORC1 signaling pathway, which can be more activated by palatable food (sweet food). *LARP1* is expressed in NAc, a leading center of the reward system managing food pleasantness and gratification and driving impulsive behaviour. Concerning *GEMIN5* gene, it was demonstrated that it has a link with *LPIN1*, a gene involved in lipid metabolism and adipocyte differentiation. Additional studies are needed to increase our knowledge of the role of these genes on the psychological and biological factors of TP and EB.

P038 Psychometric functions for alpha-ionone in young adults

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Psychometric functions in olfaction are relatively understudied, but may provide insight into underlying mechanisms in olfactory processing. Olfactory psychometric functions in at least some mammals often exhibit non-monotonic functions, including significant 'notches'. This has been reported for a limited set of odors, including amyl acetate (Cameron & Doty, AChemS, 2018, 2019) and alpha-ionone (Marshall & Moulton, 1981). Self-reported olfactory function is not well correlated with olfactory performance and less is known about trial-by-trial confidence in olfaction tasks. In the current study we replicated and extended previous findings. We explored psychometric functions in college students who completed a 2-AFC detection task using "Snap & Sniff®" Sensonics wands. On each trial two wands were presented in rapid succession, one containing alpha-ionone (a violet-like odor) at one of 10 predetermined concentrations and the other containing only mineral oil. The participant's task was to indicate which one seemed stronger and to indicate their confidence. In one condition, 24 undergraduates (6 males) completed a single 30-minute test session of 60 trials. In another condition, 9 undergraduates (6 males) each completed 10 30-minute test sessions of 60 trials. We found that although performance increased with concentration, it did not increase monotonically. Instead, we observed consistent 'notches' – performance increased as concentration increased, but near threshold, performance was lower at higher concentration than at lower ones. Interestingly, performance was nearly identical in our two conditions. Consistent with our previous findings, confidence increased exponentially as performance improved. These data support the previously proposed dual receptor theory.

P039 Crossmodal c–gnition - does odour influence colour perception?

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Since odours are associated with information from other sensory modalities (Speed et al., 2021), and the primary olfactory cortex responds to multisensory information (Porada et al., 2019), it is likely that multisensory information can play a role in odour perception and cognition. Here we explore how odour is connected with the other senses, and whether odour can influence basic colour identification.

In order to investigate the association between odour and other sensory modalities, participants were presented with a set of common odours one at a time and asked to rate how strong each odour is associated with each of the other sensory modalities (vision, gustation, audition, haptics, interoception.) Participants were then asked to explicitly describe the specific sensory associations they have with each odour (e.g., specific colours, shapes, sounds). For each odour, a vector of strength of associations across the senses for each odour the most frequently reported associatIns were identified.

From this first experiment, common odour-colour pairings were identified. The second part of this study tested whether the presentation of odours facilitated colour identification. Participants were presented with a range of odours and, using a two alternative forced choice task, asked to identify the colour presented on a screen. This experiment tested whether the congruency of the colour-odour pairing facilitated colour discrimination, the results of which will be presented here.

P040 Neurosensorial cluster of post-COVID 19 syndrome: a prospective psychophysical assessment of smell and taste function and impact on quality of life

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COVID-19 pandemic brought taste and smell impairment to the forefront of medicine, revealing gaps in the knowledge of pathophysiological mechanisms, true prevalence and preventive and or therapeutic alternatives.

This monocentric sub-study of the EU Horizon 2020 ORCHESTRA project cohort investigates risk factors for the neurosensorial cluster of post-COVID-19 syndrome through multivariable analysis. The Sniffin' Sticks Extended Test and the Taste Strips Test were applied to evaluate smell and taste function, respectively. SF-36 questionnaire was applied to assess the quality of life. The evolution of neurosensorial symptoms and the outcome of olfactory training were assessed through phone-call interviews.

Out of 1187 patients (female, N=630), 550 (47%) reported a smell/taste impairment, with a lower risk for older age and monoclonal antibodies treatment, and a higher risk in females ($p<0.001$). Out of 50 patients undergoing the psychophysical evaluation, 66% showed a smell quantitative impairment, while a qualitative deficit was present in 50% of patients with hyposmia and 35% of normosmic patients. Hypogeusia was present in 28% of patients, with 56% showing a qualitative disorder. In addition, 53% of normogeusic patients presented a qualitative disorder. Among the patients who completed the olfactory training, 75% still reported smell impairment. Through the SF-36 questionnaire, smell and taste impairments only impacted the mental vitality (energy and fatigue) score. The neurosensorial cluster assessed showed a complex, fluctuating, and multifaceted presentation. Deep quantification and characterization of the post-COVID-19 neurosensorial impairment is crucial for better understanding the SARS-CoV-2 long-term sequelae.

P041 The importance of self-awareness: subjective measures associated to objective olfaction, cognition, and dementia outcomes.

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Self-reported measures emerge as potential indicators for early detection of dementia and mortality. We investigated the predictive value of different self-reported measures, including subjective cognitive decline (SCD), subjective olfactory impairment (SOI), subjective taste impairment (STI), and self-reported general health, to determine the risk of progressing to Alzheimer's Dementia (AD), Parkinson's Dementia (PD) or any-other-cause dementia.

A total of 6028 cognitively uIimpaired individuals from the 8th-wave of the English Longitudinal Study of Ageing (ELSA) as baseline sample and 5297 individuals from the 9th-wave as two-year follow-up sample were included in this study. Self-rated measures were assessed using questions from the ELSA structured interview. Three logistic regression models were fitted to predict different dementia outcomes.

SCD based on memory complaints (Exp(B) = 11.145; p < 0.001), and older age (Exp(B) = 1.108, p < 0.001) significantly predicted the progression to AD dementia at follow-up. SOI (Exp(B) = 7.440; p <0.001) and older age (Exp(B) = 1.065, p = 0.035) significantly predicted the progression to PD dementia at follow-up. SCD based on memory complaints (Exp(B) = 4.448; p < 0.001) jointly with complaints in other mental abilities-not memory (Exp(B) = 6.662; p < 0.001), and older age (Exp(B) = 1.147, p < 0.001) significantly predicted the progression to dementia of any other cause (i.e. non-AD, non-PD).

Different types of complaints are specifically associated with different dementia outcomes. Our study demonstrates that self-reported measures are a useful and accessible tool when screening for individuals at risk of dementia in the general population.

P042 Could Odor Induced Taste Enhancement happen earlier than we think?

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When eating, some odours contained in the food can reach the olfactory epithelium by the retronasal pathway and enhance taste perception. This mechanism is known as the Odor-Induced Taste Enhancement (OITE; Ai and Han, 2022). Taste and smell unification which leads to OITE has recently been measured using Electroencephalography (EEG) as this method has a high temporal accuracy and represents a useful tool to investigate and understand better the chronometry of the multisensory integration. Recent EEG research suggested that OITE is a late cognitive processing occurring in higher-order brain regions independently of early perceptual processing (Sinding et al., 2021). However, these mechanisms are still debated (Small et al., 2013) and require further investigations. Recording evoked cerebral responses (ERPs) coming from different sensory systems concomitantly is difficult, especially because of the retronasal olfactory delays of perception and EEG constraints. By testing and better controlling different stimulation parameters, we aimed to improve the quality and the consistency of the ERPs acquired thus improving the interpretability of the brain processing of flavor. Thus, we automatized the stimulations delivered in the mouth by a gustometer based on participants breathing out. We also asked partiIipants to ”nsta’taneously swallow to resynchronize the gustatory and olfactory perceptions. We hypothesized that this would lead to larger and more stable peaks related to both perceptual and cognitive brain components which could help identify more precisely OITE processing and when taste and smell are unified. The data are currently under analysis and will be discussed.

P043 Learning to discriminate different odors engages plasticity at distinct olfactory processing stages

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The specificity and transfer of olfactory learning inform the locus of neural plasticity and rehabilitation therapies for olfactory loss. In this study, we report long-term perceptual learning in a simple odor discrimination task involving either binary odor mixtures of various ratios or odor enantiomers. Training was conducted unilaterally and led to steadily improved discrimination performances, from a chance level

of 33% to over 80%. For odor mixtures, the perceptual gain transferred completely to the untrained nostril and generalized to other untrained odor mixtures. However, for odor enantiomers, the perceptual gain was confined strictly to the trained nostril and did not generalize to odor enantiomers that were structurally dissimilar to the trained ones. These contrasting results indicate that concentration ratio and chirality are encoded as distinct olfactory attributes, and that odor discrimination learning can occur in either early or late olfactory processing areas, depending on which attribute is task-relevant.

P044 Altered white matter architecture in patients with congenital anosmia: a tract-based spatial statistics study

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Congenital anosmia (CA) renders patients incapable of perceiving smells from birth. This anomaly features underdevelopment of the olfactory bulbs, leading to a deficiency in olfactory input to the brain. Previous research has shown increased volume or cortical thickness in multiple gray and white matter areas of CA patients. A subtle increase in fractional anisotropy (FA) in the orbital frontal cortex was also found in a diffusion tensor imaging study. In this study, we further investigated the alterations of white matter architecture in CA patients.

This study enrolled 8 CA patients as well as 14 age- and gender- matched healthy subjects. Whole-brain diffusion tensor imaging was performed using a 3T MR scanner. We analyzed the difference in major white matter tracts and olfaction-related areas between CA patients and health controls through fiber tract-based spatial statistics (FSL, FMRIB software library).

The results revealed that CA patients exhibit decreased FA in the right superior corona radiata (SCR) (MNI coordinate: [25, -21, 30]), suggesting damaged or demyelinated fiber bundles in this area due to a lack of olfactory input throughout their lives. Moreover, we found a positive correlation between FA values extracted from the identified SCR cluster in normosmic individuals (n=14) and their performance on the Sniffin' Sticks test for odor identification ($r=0.53$, $p=0.049$). This suggests that SCR plays an important role in mediating olfactory information and semantically formation of odor perception.

P045 Contribution of Olfactory-driven Oscillations to Social Interaction in Mice – A Critical Validation of Interbrain Synchrony

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Social interaction involves extensive information exchange, behavioral coordination, and shared cognitive states between individuals. Remarkably, socially interacting brains exhibit some degree of coordination and synchronization, or interbrain synchrony, which may encode socially relevant information and enhance social interaction. Interbrain synchrony has been observed in the medial prefrontal cortex (mPFC), a key hub in social cognition. Meanwhile, respiration-entrained oscillations in the olfactory system are increasingly recognized as a powerful coordinator of neuronal activity in many brain areas,

including the mPFC. However, the role of respiratory rhythms has been entirely unconsidered in the context of social interaction and interbrain synchrony. Here, we test the hypothesis that coordinated olfactory inputs among individuals in social settings contribute to interbrain synchrony via an olfactory-mPFC circuit. Local field potentials (LFPs) from the mPFC and olfactory bulb (OB) were simultaneously recorded from in freely behaving pairs of mice. Synchrony profiles of neural activity were established by measuring the coherence and Pearson's correlation of the power spectrum between and within animals. Next, the nasal epithelium was eliminated with methimazole to directly test the contributions of nasal breathing and volatile social odors on mPFC activity, interbrain synchrony, and social behavior. The OBs of socially interacting mice show increased synchrony relative to mice that are alone or not interacting. This pattern holds when evaluating the synchrony between mPFCs, and between the OB and mPFC within the same animal. Finally, nasal epithelium ablation increased synchrony measures in almost all conditions, prompting future exploration of top-down influences on OB oscillations.

P046 Behavioral signatures of olfactory perceptual learning

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Animals continuously accumulate knowledge about their environments through sensory experience and active exploration. This unreinforced perceptual learning can facilitate future associations across sensory modalities and between known sensory stimuli and reinforcers. Perceptual learning also guides investigative behavior. For example, animals respond to novel odor stimuli by increasing sniffing rates, while appearing to ignore familiar ones. Changes in sniffing behavior provide an especially relevant behavioral correlate to odor perceptual learning as they invoke a cognitive-behavioral loop whereby memory processes directly alter active sampling behaviors. However, during repeated odor stimulus exposure, neural population responses at multiple stages of olfactory processing exhibit ongoing changes independent of the rapid habituation of sniffing responses. We hypothesized that behavioral odor responses may reflect ongoing neural response plasticity in subtle but measurable ways beyond the metric of inhalation rate. To test this, we monitored and quantitatively characterized additional respiratory features and orofacial responses of head-fixed mice during repeated presentations of a panel of novel odors separated by varying retention intervals. As expected, sniffing rapidly habituated within sessions, but recovered variably across sessions dependent on the retention interval and the total amount of experience. We characterized the structure of variance in orofacial and sniffing responses across trials using dimensionality reduction approaches and found that multiple components with distinct dynamics contribute to the overall behavioral changes exhibited during olfactory perceptual learning. Ongoing work will determine whether behavioral changes during odor learning predict memory persistence and relate these changes to underlying neural population activity.

P047 The stochastic wiring of olfactory local interneurons

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The types of neurons are defined by their morphologies, molecular profiles, neurotransmitters, electrophysiological properties and connections. However, neuronal variability and stochasticity largely complicate the definition of neural types and the circuit activities the neurons involve. We recently demonstrated that a single identified olfactory interneuron, TC-LN, exists as many as 849 functionally distinct innervation patterns across individuals. Such variations originate from developmental stochasticity and experience-dependent plasticity, which change their connections. To explore different forms of

neuronal variability, a large-scale GAL4 screen was conducted to identify drivers that label identifiable single or the same types of olfactory interneurons. The screen ended with a GAL4 line labeling patchy LNs. Remarkably, patchy LNs have stochastic innervation patterns, while all patchy LNs collectively tile the *Drosophila* antennal lobe. Certain biological constrains limit the stochasticity of patchy LNs: the sphericity and size of glomeruli are the external (environmental) constrains and neural activity is the intrinsic constraint. How patchy LNs may collaboratively integrate the olfactory information across glomeruli will be discussed. In addition, different types of interneuron variability will also be further discussed.

P048 From olfaction to oviposition: A global antennal-lobe network is associated with oviposition behavior in the female moth

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As in other organisms, insects possess neural circuits linked to perception of odorants that induce opposing behaviors, such as attraction and repulsion. We recently identified three fatty acid methyl esters (FAMEs) emitted from eggs of the moth *Helicoverpa armigera* which effectively deter oviposition. These FAMEs (methyl oleate, methyl palmitate, and methyl stearate) are detected by the female-specific olfactory receptor HarmOR56, located on the antennae alongside many other receptors tuned to plant volatiles. During oviposition, females encounter both attractive plant volatiles and repellent FAMEs simultaneously. However, the question of how inputs from these odor categories interact within the antennal lobe (AL), the primary olfactory center, remains unanswered. Here, we investigated the response patterns of various neuron populations in the female AL to selected odor cues (FAMES and linalool). First, calcium imaging of uniglomerular projection neuron (PN) populations revealed odor-specific responses during odor exposure. Subsequent intracellular recordings combined with inotropic staining procured high-resolution data not only from PNs but also from other neuron types within the AL network, totally including eight neuron types: olfactory sensory neurons, AL PNs confined to one of five different tracts, local interneurons, and centrifugal neurons. We found distinct response patterns across neuron types. Generally, attractive odors elicited responses in a relatively restricted number of neuron types, while repellent cues evoked responses in almost all neuron types. Our findings suggest that the repellent cues engage a broader network within the AL compared to attractive cues.

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P049 Real-world observational data on olfactory dysfunction from the smell and taste clinic of UZ Leuven (Belgium) from 2021-2024

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Background: The COVID-19 pandemic led to a surge in olfactory dysfunction (OD), prompting the need for specialized care pathways. This study explores the prevalence, characteristics, and clinical implications of OD in patients at the Smell & Taste Clinic, University Hospitals Leuven (UZL).

Methodology: We included consecutive patients with OD in the observational longitudinal ProspeRo'Scent registry at UZL between September 2021 and April 2024, after comprehensive assessment with psychophysical tests (Sniffin' Sticks TDI and Taste sprays) and questionnaires.

Results: Of the 203 patients, COVID-19-associated OD (C19OD) was the predominant etiology (50.2%), followed by idiopathic (25.1%), and post-traumatic (8.9%). Parosmia was reported in 60.2% of patients, with the highest prevalence in C19OD cases (80.9%). Psychophysical tests indicated that parosmia patients had better olfactory thresholds and discrimination scores. During follow-up (n=116; average 7.7 months), 31% of C19OD patients exhibited clinically relevant improvement in TDI scores, compared to 13% with other etiologies. Quality of life, assessed by sQOD-NS, was not significantly different between etiologies but correlated with higher parosmia scores.

Conclusions: The COVID-19 pandemic has altered the profile of OD patients, with C19OD being the predominant cause and parosmia highly prevalent. C19OD patients demonstrated a higher likelihood of clinically relevant improvement over time compared to other etiologies.

P050 Exploring the Influence of Ambient Odours on Affective, Physiological, and Brain Responses in French Young Adults

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Understanding the impact of odours on human emotion is a fundamental aspect of olfaction research. While previous studies have predominantly used direct invasive odour delivery methods, our study delves into the effects of ecologically relevant odours on affective, physiological and brain responses to ambient odors delivered through high-tech controlled odor-speakers.

Twenty-one French young adults participated in audiobook listening sessions while exposed to three ambient odours: neutral (triethyl citrate), positive (menthol), and negative (cadaverine). Cardiac and respiratory activity were continuously monitored, and cerebral responses were recorded using EEG. Participants reported their affective experiences through post-condition questionnaires.

Despite the absence of significant physiological findings, subjective responses revealed distinct effects of ambient odours on affective states. Menthol, the positive odour, elicited heightened feelings of energy and well-being, whereas cadaverine, the negative odour, prompted increased irritation, disgust and desired to leave. Analysis of EEG data unveiled greater alpha and beta band activities in central and parietal brain regions in response to both positive and negative odours. Additionally, menthol exhibited prolonged frontal brain responses compared to the other conditions.

The findingI presente" in 'ur study reveal the significant impact of ambient odours in modulating affective responses at both the subjective and neural levels. Our results emphasize the nuanced interplay between olfaction and affective states, shedding light on the potential societal power of ambient odours in modulating concentration, decision making and social behavior.

P051 Combining AI and mass spectrometry to analyze odorant molecules.

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Artificial Intelligence (AI) has emerged as a promising tool in the analysis of data generated by mass spectrometry techniques used for identifying chemical compounds, including volatile organic compounds and odorant molecules. Machine learning algorithms can be trained on large datasets of mass spectra to learn patterns and relationships between the m/z ratio and intensities of fragment ions and the corresponding molecular structures of the analyzed compounds. We demonstrate that these models can predict the identities and similarities of unknown compounds based on their mass spectra, improving performance and reducing analysis time compared to conventional methods. Combining these techniques with AI could lead to highly sensitive, rapid, and cost-effective methods for detecting odorants in diverse areas, from environmental monitoring to quality control in food and perfume industries.

P052 Navigating the unknown: unearthing novel ligands of insect odorant receptors through docking and electrophysiology

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Olfaction is a crucial sense for insects as it drives main behaviours, such as locating food sources, finding mates, and selecting oviposition sites. Odorant receptors (ORs) play a key role in this process in converting chemical cues into electrical signals, which are then transmitted to the central nervous system, potentially leading to the elicitation of a specific behaviour. However, many of these ORs remain orphan. This is primarily because traditional experimental methods are constrained by the vast number and diversity of potential ligands, making it challenging to thoroughly investigate the complete spectrum of OR responses to volatiles. In response to this challenge, we present a structure-based approach that combines virtual screening and electrophysiology experimentation. While such strategies have been utilized for mammalian odorant and taste receptors, as well as insect odorant binding proteins, our work represents a pioneering application specifically targeting insect ORs. We developed a workflow that integrates protein modelling and virtual screening, calibrated with prior experimental data. This allows for precise discrimination between potential OR non-agonists and agonists from an extensive database of more than four hundred thousand natural compounds. We further validated the predictions using *in vivo* tests on two selected ORs from the crop pest moth model, *Spodoptera littoralis* (Lepidoptera; Noctuidae): *Slit*OR25, a broadly tuned OR, and *Slit*OR31, a specific OR. Our study underscores the remarkable efficacy of our approach in identifying novel ligands for both receptor types, unlocking unexplored regions within the chemical space detected by these proteins, traditionally overlooked by conventional experimental methods.

P053 The perception of gender in two sex-specific body odor compounds MSH and HMHA

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MSH (3-methyl-3-sulfanylhexan-1-ol) and HMHA (3-hydroxy-3-methylhexanoic acid) are two sexually dimorphic compounds present in human sweat. MSH is more typically feminine while HMHA is more typically masculine. Here we investigated whether it was possible to explicitly identify these two compounds as such. We tested this using an explicit task, i.e. rating the odors on a scale from "very

masculine" to "very feminine". This task was implemented on a very large sample of men and women of all ages in a museum. We hypothesize that gender differences may occur, reflecting either a general superiority of women in odor processing and/or a specific processing related with a role of the compounds in opposite-sex attractiveness (such as men's higher pleasantness ratings of the female compound MSH and/or women's higher pleasantness ratings of the male compound HMHA). Analyses were performed on a final database of 2716 individuals (1685 females, ages = 6-90). Analyses with Bayesian mixed-effects models revealed that only women rated MSH as more feminine than HMHA. However, this effect was very small. Moreover, the ratings of masculinity/femininity were extremely variable among the population. Women also rated the odors as more intense and less pleasant than men did. Overall, the results do not argue in favor of a function of MSH and/or HMHA in male-female attractiveness, but are in line with the known gender influences in odor perception. Future studies could benefit from the identification of new sexually dimorphic compounds and from using designs where the effect of odors are tested more implicitly.

P054 Human piriform cortex differentiates odors by identity, valence, and edibility

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When a new odor wafts its way into our awareness, how long does it take us to recognize? To decide that we like it? Or whether we want to eat it? And how is this evolving olfactory experience reflected in our brain activity? Here, we paired an odor feature rating task with high temporal resolution intracranial recordings to investigate the neural signatures of human olfactory perception. On each trial, participants evaluated a real-world odor (e.g., cheese, dirt, lemon, shampoo) on one of three dimensions: (i) pleasantness, (ii) edibility, or (iii) identity. Participants' ratings reliably differentiated pleasant and unpleasant odors as well as edible and inedible odors. Participants also overwhelmingly endorsed the true label of an odor versus an incorrect foil label. To compare behavior with odor-related brain activity, local field potentials were simultaneously recorded via surgically implanted EEG electrodes (placed as part of treatment for intractable epilepsy). Electrodes in piriform cortex were selected for analysis. We saw pronounced odor-evoked increases in theta band power (in piriform, but not control regions). A set of support vector machine classifiers were trained to decode neural responses based on odor identity, valence, or edibility. Early results demonstrate above-chance decoding on all three dimensions. Future analyses will reveal the nuances of the odor code as it evolves over time.

P055 Active odour sampling in the Americ–n cockroach - behaviour and odour mapping

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Motion plays an essential role in sensory acquisition. From changing the position in which information is acquired to fine-scale probing, animals actively control the way they interact with the environment. This talk will present our findings on the dynamic role of antennal movements in olfaction in the American cockroach as well as our recent work on odor mapping in the antennal lobe. Behavioural tests in a wind-tunnel setup show that cockroaches locate and track static and moving odours by shifting the antennae towards the plume centre and increasing local movement bouts. These were particularly pronounced for attractive odours and are accompanied by high-frequency antennal sweeps and vertical strokes, which were shown to create local fluctuations in odour concentrations. I will discuss potential implications of

these for facilitating odour capture and transport, which may be especially relevant in low airflow environments, where cockroaches reside.

P056 Narrow taste receptor tuning to fructose in a vertebrate

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Sensory receptors enable organisms to perceive the world, directly affecting their survival. Sweet taste is a phylogenetically widespread taste ability, allowing animals to detect the dietary carbohydrates necessary to fuel metabolism. Among naturally occurring sugars, sucrose commonly elicits the strongest response by the vertebrate canonical sweet taste receptor T1R2-T1R3, as well as by the convergently repurposed T1R1-T1R3 (umami) receptor used by multiple bird clades to sense sugars. Although some invertebrates have receptors that respond selectively to fructose, specific tuning of vertebrate sugar receptors to non-sucrose sugars has not been documented. Here, we find evidence for strikingly atypical sweet-sensing in a mousebird (*Urocolius indicus*), an early-branching landbird from South Africa that specializes on hexose-rich diets, such as mulberries or the nectar of *Aloe* plants. Mousebirds not only neofunctionalized their original umami receptor to detect sugars, similar to hummingbirds, woodpeckers and songbirds, but also exhibit an extraordinarily narrow tuning of their receptor to fructose only. We combine functional testing of T1R receptors as well as ancestral reconstruction and chimeric dissection to investigate the molecular basis and phylogenetic origin of this unusual response, providing insight into the evolution of receptor tuning and the consequences of dietary specialization.

P057 Demystifying wine expertise through the lens of imagination: Descriptions and imagery vividness across sensory modalities

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Grounded cognition theories suggest sensory-specific sensory representations in the brain are shaped by experience. Senses are experienced differently, e.g., Western societies giving relatively more attention to vision compared to smell. This is also reflected in cognition, e.g., people express their sensory experiences differently in language, and differ in their vividness to imagine these sensory experiences. Experience in one domain, from a personal interest, or from culture, might mitigate the difference.

Here, the relationship between mental imagery and language use for wine was studied. Wine experts and novices participated in an online survey where vividness of imagined wine was measured, and they were also asked to describe the same imagined wines in words.

Results show that, compared to novices, experts exhibit more vivid imagery for smell, taste, and mouthfeel, but not vision. Experts provided longer descriptions, use more source-based descriptors and fewer abstract descriptors, and employ more concrete language, particularly for smell and taste. Regression models suggest a link between language variables and imagery vividness, with expert language better at predicting expert imagery vividness than novice language on novice imagery. At the same time, no single linguistic variable predicted imagery vividness across both populations of novices and experts.

This study reveals cognitive differences between experts and novices in wine imagery, highlighting the influence of expertise on sensory representations and language use. Future work could explore the developmental trajectory and details of this relationship, and/or could focus on the practical applications of found effect of experience on sensory language.

P058 The olfactory reference syndrome – data on a new diagnosis

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With the rele[as]e of the 11th version of the international classification of diseases, the World Health Organization implemented a new mental health diagnosis: the olfactory reference syndrome (ORS). This syndrome, categorized under the umbrella of obsessive compulsive disorders, is defined by an excessive worry to emit a compulsive body odor. Hence, patients do not suffer from having an objectively repulsive odour, but from the worry that their smell will be perceived as such by others. Utilizing the definitions outlined in the ICD11, we developed a ORS questionnaire and tested its coherence to olfactory sensitivity, body odor disgust and mental health.

We surveyed 277 individuals aged 18-63 (188 women) with the ORS, other questionnaires and we performed olfactory screening using the Sniffin Sticks.

Principal component analyses identified three components (social worries, checking behavior, believe of aversive body odor), explaining a variance of 38.6%. While the latter two varied between test- and re-test and were reported frequently, social worries were less often and tended to be stable over time.

ORS was not related to olfactory sensitivity, nor to the subjective importance of olfaction or to body odor disgust. However, ORS related to mental health with positive correlations to somatic symptoms ($r=0.314$, $p<0.001$), depression ($r=0.372$, $p<0.0019$) and anxiety ($r=0.410$, $p<0.001$).

The results obtained in a selective student sample confirm the classification of ORS as a mental disorder.

P059 A Neural Substrate for Encoding the Probability of Sensory Inputs

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Estimating the statistics of events occurring around us is a crucial feature for survival. However, how the brain achieves this is poorly understood. We devised an odor-discrimination task in which mice could utilize preceding odor cues to estimate the probability of encountering a followed rewarded or non-rewarded odor. Recording the neural activity during task performance in the primary olfactory cortex, we found two non-overlapping neuronal subpopulations that encode odor probability contingencies differentially. One subset of neurons ramped its firing rate between the cue and the predicted odor onset, proportionally to the predicted probability. The second subpopulation encoded the target-odor prediction error, with a more robust response to the rewarded odor when it was less probable and a weaker response when it was more probable. Reversing the probability contingencies remapped the activity in these neural populations to reflect the newly learned probabilities. Bilaterally silencing the orbitofrontal cortex using DREADDs hampered mice ability to utilize the cue-probability contingencies and compromised neuronal probability coding in the olfactory cortex, while task learning remained intact.

These results demonstrate that primary olfactory cortex neurons encode the probability of an odor event and its prediction error, and that these encodings require centrifugal inputs from the orbitofrontal cortex.

P060 Characterising insect olfaction genes using CRISPR/Cas – unravelling pheromone biosynthesis in a pest moth

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CRISPR/Cas as a molecular biology tool is rapidly gaining popularity in insect research, especially for gene characterisation and in applied science related to pest- or vector control with genetically modified lines. In the study of insect olfaction, odorant receptors, odorant binding proteins or pheromone biosynthesis genes have been knocked out in moths, flies, locusts, mosquitoes and ants, causing changes in phenotypes and behaviour and revealing gene functions.

We have investigated the pheromone biosynthesis pathway of the oriental fruit moth *Grapholita molesta* (Lepidoptera: Tortricidae), a severe pest on peach and other high-value fruit crops in temperate zones. Insecticide treatment has led to resistance development, but the use of sex pheromones in pest management has shown great promise. The purpose of this study was to harness pathway genes in the biotechnological production of sex pheromones in cell factories, for use in pest management.

Experiments with isotope-labelled fatty acid precursors revealed the involvement an uncommon Δ8 fatty acyl desaturase in production of the main pheromone component (*Z*)-8-dodecenyl acetate (Z8-12:OAc), which was also highly expressed in the female pheromone gland transcriptome. CRISPR/Cas9 knock-out of the candidate desaturase gene blocked production of the pheromone completely. Heterologous expression in yeast- and Sf9 insect cells, however, failed to demonstrate the expected function, instead suggesting an ancestral desaturase activity. Our work advances the development of sustainable pest management as well as the understanding of pheromone evolution in an important family of insect pests.

P061 Bitter taste receptors on human peripheral blood mononuclear cells play a functional role in the chemokine immune response to SARS-COV-2 peptide pools

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Severe SARS-CoV-2 infections are associated with a pro-inflammatory burst of cytokines and chemokines. Bitter taste receptors (TAS2Rs) have been shown to modulate the cytokine release in cell culture, yet their biological function *in vivo* is unclear.

We hypothesized SARS-CoV-2 peptide pools (PP) to alter the cytokine/chemokine immune response through TAS2Rs in human peripheral blood mononuclear cells (PBMCs).

This was investigated in an *ex-vivo* approach by RTqPCR and ELISA in PP-treated PBMCs w/o co-incubation of a TAS2R antagonist and knock-down experiments. CXCL-9, CCL-7 and CCL-2 chemokines were chosen as outcome measures due to their strong response to PP treatment on both RNA transcript and protein secretion levels. PP treatment increased the RNA expression levels of *TAS2R14, -3, -4, -13* and *-41* after 3hrs of incubation and *TAS2R14, -31, -13, -10* and *-41* after 6hrs of incubation, demonstrating a PP-induced TAS2R mRNA regulation. A 24h co-incubation with PP and homoeriodictyll, a potent interaction partner of TAS2R14, -31, -43, -50, -20 and -39, reduced the PP-induced CXCL-9, CCL-7 and CCL-2 chemokine secretion by a mean of 90 % (p<0.01), 96 % (p<0.001), and 96 % (p<0.05), respectively. Knock-down of abundantly expressed and broadly tuned *TAS2R14* confirmed the involvement of this bitter taste receptor in the chemokine immune response in PBMCs, decreasing the CXCL-9, CCL-7 and CCL-2 chemokine secretion after 24h of PP treatment by 79 %, 95 % and 95 % (all p<0.05), respectively.

We, therefore, hypothesize TAS2Rs as potential targets for modulating immune responses in virus infections.

P062 Inhaling different coffee aromas can elicit different feeling states: Results from sensory testing

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Olfactory cues in food and beverage can rapidly modulate feeling states. Recent studies suggest that inhalation of coffee essential oils can promote positive mood and cognitive performance, however, limited evidence is available on the role of brewed coffee aroma.

Sensory testing was conducted to examine the differential effects on feeling states of three distinct coffee aromas profiles: coffee Arabica characterized by biscuit aromatic notes; a mix of Arabica and Robusta with spicy aromatic notes and a mint flavored coffee Arabica. In a single session, 36 coffee drinkers were asked to report their feeling states right after inhaling, in a randomized order, the three coffee aromas, as well as a negative control.

Results from linear mixed models revealed a significant effect of inhaling the coffee aroma characterized by spicy notes (mix of Arabica and Robusta) on feelings of contentedness. None of the aroma profiles affected feelings of alertness. These findings suggest that above cup coffee aroma inhalation can rapidly elicit positive feeling states, depending on its characteristics (aromatic notes, coffee specie).

Future studies should investigate which factors and mechanisms may contribute to these effects.

P063 The Proust Effect: phenomenological and neural bases of childhood olfactory autobiographical memory

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Marcel Proust, in his book Swann's Way (1919), recounts the profound joy triggered by the scent of a madeleine dipped in linden tea, transporting him back to afternoons spent with his aunt. This

autobiographical memory is intricately linked to olfactory experience. Some studies have showed that autobiographical memories triggered by odorants are reported as older and associated to a greater positive emotional valence. However, limitation of these studies relies on the arbitrary choice of odorants used for stimulation, not necessarily relevant for the participants. We therefore proposed to decipher the phenomenological characteristics of this memory usi'g the subject's spontaneous, personal recollection. Thanks to an online survey, we investigated the relation between the hedonic value of odors and the emotional value of memory throughout the ages. We also compared the characteristics of the oldest olfactory memory with those of another oldest memory lacking an olfactory component. Importantly, to go further and better understand the Proust effect, we modelled a positive olfactory episodic memory in infant mice and studied its neural signature in adulthood. We revealed that childhood olfactory memory is associated with the recruitment of P1-born granule cells in the olfactory bulb, the first cortical relay of the olfactory information. We then analysed the output message from the olfactory bulb to higher-order brain structures and identified a pattern of correlated activity specific of this odor memory. Thus, this project provides important insights into how the brain underpins the persistence of the early and powerful olfactory memory.

P065 Investigating the relaxing/stimulating properties of fragrances in humans

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It seems to be fairly well accepted that smells have a relaxing or stimulating effect. In this talk I will present a number of studies we conducted that have attempted to characterise this phenomenon at different levels of the individual. We will first look at the subjective experience of relaxation or stimulation through cross-cultural experiments conducted in different languages. We will then show that this verbal report of a feeling is accompanied by implicit processing processes that reveal privileged associations between certain odours and their relaxing or stimulating properties. We will also investigate the short-term cerebral consequences of exposure to relaxing and stimulating odours. Finally, we will investigate the short-term physiological consequences of exposure to relaxing or stimulating odours. This research highlights the advantage of a multi-component approach to an affective dimension such as activation (arousal) for a better basic understanding. We will also discuss how the methods developed in this type of research can help manufacturers to offer truly relaxing or stimulating products.

P066 Single cell transcriptomics of vomeronasal neuroepithelium reveals a differential endoplasmic reticulum environment amongst neuronal subtypes

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Specialized chemosensory signals elicit innate social behaviors in individuals of several vertebrate species, a process that is mediated via the accessory olfactory system (AOS). The AOS comprising the peripheral sensory vomeronasal organ (VNO) has evolved elaborate molecular and cellular mechanisms to detect chemo signals. To gain insight into the cell types, developmental gene expression patterns and functional differences amongst neurons, we performed single cell transcriptomics of the mouse vomeronasal sensory epithelium. Our analysis reveals diverse cell types with gene expression patterns specific to each, which we made available as a searchable web resource accessed from

www.scvnoexplorer.com. Pseudo-time developmental analysis indicates that neurons originating from common progenitors diverge in their gene expression during maturation with transient and persistent transcription factor expression at critical branch points. Comparative analysis across two of the major neuronal subtypes that express divergent GPCR families and the G-protein subunits Gnai2 or Gnao1, reveals significantly higher expression of endoplasmic reticulum (ER) associated genes within Gnao1 neurons. These gene expression patterns, along with differential localization of ER chaperones, structural proteins as well as electron microscopy ultrastructural data indicate fundamental differences in ER function associated with neuronal differentiation.

P067 Making Sense of Murine Olfactory Sensitivity

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Perceptual measures of olfactory sensitivity reflect the responses derived from the complete repertoire of olfactory receptors (OR) and therefore provide a mechanism to compare the sensitivity of different species, gauge appropriate stimulus concentrations for functional experiments, and develop hypotheses regarding the evolutionary pressures that have shaped the OR gene repertoire. The goal of this study was to determine how odorant features are correlated to murine sensitivity. We collated our published measures of murine sensitivity (24 odorants belonging to 4 different classes) using our robust psychophysical approach combined with a photoionization detector method to validate vapor-phase concentration. We found that sensitivity was negatively correlated with volatility and trended towards a positive relationship with the air-mucus odorant partition coefficient. We failed to find any correlations between murine sensitivity and either molecular weight, atmospheric lifetime of an odorant (a measure of odorant stability), or the Euclidian distance between odorants. We also compared our estimates of murine sensitivity to well-controlled psychophysical measures in humans. In general, we found that mice are more sensitive to alcohols and terpenes, while humans are more sensitive to acetates. We hypothesis that the enhanced sensitivity of mice to these compounds reflects an evolutionary pressure to identify unspoiled grains and insects, which are major food sources for wild mice. Beyond aiding researchers in using appropriate stimulus concentrations for functional studies in mice, these sensitivity measures may be able to shed light onto the evolutionary pressures that have shaped their olfactory system.

P068 Evolution of the Or67d sex pheromone receptor in Drosophila flies

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Insects use pheromones for inter- and intra-specific communication. Therefore, sex pheromone perception plays an important role in speciation, as it governs the attraction of conspecific potential mates and the repulsion of individuals from other species. In *Drosophila* Or67d detects cVA, a male-produced pheromone that renders males more attractive, and after being transferred to a female during copulation decreases the attractiveness of the freshly mated female to other males. Here we express orthologues of OR67d of different *Drosophila* species in the empty neuron system of *D. melanogaster*, and afterward

perform single sensillum recordings to previously identified male-specific compounds of the corresponding species. By this, we are investigating how OR67d might have evolved to respond to a diversity of male-specific compounds, potentially driving speciation within the genus, i.e. we investigate the coevolution of a pheromone receptor and the corresponding pheromone.

P069 Cxcr4 is expressed within the basal neuronal lineage of the VNO and regulates the homeostasis of neurogenesis

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The vomeronasal organ (VNO) serves as an olfactory organ for the detection of non-volatile molecules, facilitating intra- and interspecies communication and regulating behavioral responses such as aggression and reproduction. Throughout life, vomeronasal sensory neurons (VSNs) are continuously replaced by neurogenesis from the vomeronasal stem cell niche, primarily in the marginal zone of the VNO. Considering that CXCR4 is required for neurogenesis in the main olfactory epithelium (MOE), we here aimed to investigate its role in VNO neurogenesis.

Analysis of a public available single cell RNA sequencing dataset of adult mice (Katreddi et al.; GSE190330) shows expression of *Cxcr4* within globose basal cells (GBCs), immature neuronal precursors (INPs) and a significantly increased expression within the basal neuronal lineage in comparison to the apical lineage. To investigate the role of CXCR4 signaling, we utilized mice with a conditional knockout of *Cxcr4* under the control of the 5-hydroxytryptamine receptor 3A (*Htr3a*) promoter. Immunofluorescence experiments revealed that loss of CXCR4 disturbs stem cell differentiation, resulting in a significant increase in the number of SOX2+ GBCs but a loss of SOX2+ horizontal basal cells of the sensory epithelium. Further fluorescence intensity measurements along with qPCR experiments showed I signifIcant increase in olfactory marker protein (OMP) and the G protein Gαo, exclusIvely expressed in basal VSNs.

In conclusion, loss of CXCR4 may lead to stalled transition of GBCs into INPs and increased differentiation within the basal neuronal lineage. This provides evidence for a regulatory function of CXCR4 beyond the MOE within the VNO.

P070 Insight into the olfactory system of the migratory locust, Locusta migratoria: An anatomical and cellular study

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Olfactory cues are detected by odorant receptors in the olfactory sensory neurons (OSNs) located in hair-like structures called sensilla on sensory appendages like antennae and mouthparts. In most insects, the primary olfactory centre, the antennal lobe (AL), consists of distinct globular structures called glomeruli where OSNs, the olfactory output projection neurons (PNs) and the local interneurons (LNs) interact. Stereotypically, a one-to-one wiring logic occurs, where axonal projections of single OSNs and dendritic innervations of single PNs target predominately one glomerulus (uniglomerular OSNs/PNs). In contrast, locusts (Order: Orthoptera; Sub-order: Caelifera) exhibit a unique AL organization with over 2000 micro-

glomeruli wired by multiglomerular OSNs and PNs, making locust an interesting case of the evolutionary study of olfaction systems. Our study aims to thoroughly characterise the anatomical and cellular architecture of the olfactory system in *Locusta migratoria*. Specifically, OSNs of identified sensilla are traced using single sensillum anterograde staining in order to unravel their AL circuitry patterns, with respect to sensillum type (basiconic and trichoid) and topology. On the same grounds, focal injection and intracellular staining of PNs are employed for identification of PN types and their respective wiring from the AL to higher brain centres (mushroom body calyces and/or lateral horn). We believe that our study can provide insights into the complex construction of this particular olfactory system, contributing to a better understanding of its function.

P071 From Land to Water and Back Again: Neuroanatomical Adaptations of the Olfactory System in Hemiptera

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Hemiptera constitutes one of the largest and most diverse insect orders. Members of the Heteropteran sub-order, known as 'true bugs', have successfully adapted to a variety of terrestrial and aquatic ecosystems. Evolutionary diversification gave rise to a lineage of secondarily aquatic true bugs (Infraorder: Nepomorpha) developing novel morphological, physiological and behavioural adaptations to freshwater environments. An exception to the aquatic lifestyle of Nepomorpha is the superfamily of Ochteroidea, which has secondarily adapted from water back to land. Despite anatomical observations, suggesting anosmia in aquatic true bugs due to the absence of olfactory brain structures typical for terrestrial insects i.e., the lack of antennal lobe (AL; primary olfactory centre) with distinct glomeruli, and of mushroom body (MB) calyces (a secondary olfactory centre), recent studies of the antennal sensilla in nepomorphan species, revealed chemoreceptive sensilla. With the present study we revisit the neuroanatomical layout of the olfactory system in three species: the backswimmer *Notonecta glauca* (Notonectidae), the creeping bug *Ilyocoris cimicoides* (Naucoridae) and the velvety shore bug *Ochterus marginatus* (Ochteridae), with emphasis on their transitions from land-to-water (*Notonecta, Ilyocoris*) and water-to-land (*Ochterus*) and their respective adaptations. In addition to the morphometric assessment and comparison of the brain regions of interest, single neuron staining techniques are employed to identify and characterise the neuronal components of the olfactory pathway, including afferent antennal sensory neurons, projection neurons that connect the sensory neuropiles with the central brain, and MB intrinsic cells (Kenyon cells).

P072 Molecular identification of the remarkable diversity of geniculate ganglion sensory neurons and glia

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While much is known about the taste receptor cells that detect taste qualities, considerably less is known about the oral sensory neurons located in the geniculate and petrosal ganglia that communicate this information to the CNS. The geniculate ganglion consists of two distinct populations of neurons, half are oral sensory neurons projecting to the mouth, and the other half are somatosensory neurons projecting to

the pinna. These populations are distinguished by expression of their necessary transcription factors, PHOX2B for oral sensory neurons and BRN3A for pinna-projecting neurons. Single cell sequencing techniques were applied to further characterize the oral sensory neuron populations, but the modest number of neurons that were able to be sequenced did not permit identification of uncommon cell types. Thus, critical questions remain: how many mature subpopulations of oral sensory neurons exist, how are they distinguished and what are their functions? To this end, we developed a cell nuclei isolation protocol that allowed us to drop-seq to sequence more than 22,000 geniculate ganglion neurons and 8,500 glia, providing the necessary statistical power to distinguish subclasses. This analysis identified 21 distinct subpopulations of neurons, some of which are rare, accounting for less that 1% of the total number of neurons. Remarkably, this analysis also identified 12 distinct subclasses of glia. We are currently using spatial transcriptomics to validate these findings and provide further information about their morphology and positioning within the ganglion. These data will lay the foundation for a molecular-genetic interrogation of structure-function relationships of oral sensory neurons.

P073 Olfactory perception of human body odor in mental disease

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Body odors transmit a wealth of relevant information for social interactions, such as emotions or disease in other humans. While many studies have found alterations in the human body odor for organic diseases, body odor in mental disease is largely underexplored. With this study, we aimed to investigate if body odors from mental disease are accompanied by a characteristic body odor and if this is perceived by others.

To this end, we recruited body odor donors self-reporting depressive, anxious or somatic symptoms (experimental group) and an age- and gender-matched healthy control group. Body odors were collected using cotton pads attached to the axillary region of the donors while sitting in a heated room for 45min, following a standardized hygiene protocol. These samples were then pooled and the pools described and rated by normosmic perceivers. Furthermore, the samples were analyzed for their chemical composition using gas-chromatography mass-spectrometry analysis.

We hypothesized significant differences in perceptual ratings of the body odor between the two groups, as well as on a molecular level. Preliminary results reveal differences in intensity and valence between the two groups, which seem to be backed up by group differences found through the GCMS analysis. The findings are placed in the context of altered metabolism in depression.

Although the exact causal relationships are still unclear, our results suggest a distinct body odor connected to mental illness, which is perceivable by others.

P074 High expression of odorant receptors with engineered C-terminal domains reveals unique specificity of the human sense of smell for signature odorants

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Humans have around 400 odorant receptors (OR), but reproducible receptor-ligand pairs have been reported for a minority of them, due to difficulties in heterologous expression. Starting from the observation that OR5A2 could be functionally expressed in HEK293T cells by just changing the C-terminal amino acid sequence, we engineered the C-terminal domain of functional, but still poorly expressed OR's, using the domain of the well-expressed OR5AN1 as starting point. By several rounds of mutations and introducing more basic and hydrophobic residues, a dramatically increased sensitivity of OR7C1 was achieved. The optimized sequence could be transferred to other de-orphanized OR and led to up to 500-fold improved sensitivity in HEK 293T cells. A library covering all human OR genes with the optimized C-terminal domain was synthesized and used to identify cognate OR for key natural signature odorants. Novel OR were discovered for Ambroxan from Ambergris, Rotundone, Nootkatone, Patchoulol, 2,4,6-trichloroanisol, Olibanic acid and a number of floral and fruity notes. Most of these newly de-orphanized receptors were completely inactive in HEK293T cells with the native C-terminal domain. Many of the highly expressed OR are active down to the submicromolar range, proving a high sensitivity of well-expressed OR. In addition, these OR show a high ligand specificity when comparing stereoisomers or related structures. With this enhanced expression we can for the first time better understand the pharmacology of human olfaction and find that human OR activated by signature odorants have a unique sensitivity and specificity which reflects our sensory experience to these odorants.

P075 Assessment, Classification, and Treatment of Olfactory Deficits in Post-Covid Patients at the Post Covid Center Erlangen

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Millions of people suffer from long-term symptoms following CoViD-19 infections, collectively known as "Post-Covid" syndrome. One prominent aspect of this syndrome is alterations in the olfactory system, other symptoms include cognitive impairments, fatigue or depression. However, understanding the interplay between different Post-CoViD symptoms, the varying expressions of Post-CoViD in individual patients, and effective treatments for olfactory alterations remains limited. As part of a doctoral project, we investigate a cohort of patients who have visited or are currently visiting the Post-CoViD Center Erlangen during the years 2023 and 2024. We assess the degree of smell loss in each patient using standard smelling tests and self-assessment questionnaires. These findings are then correlated with a wide range of psychophysiological parameters related to other Post-CoViD symptoms. Additionally, patients are instructed to undergo a 3-month monitored independent olfactory training using household items. During follow-up meetings, we reassess olfactory and cognitive abilities. To enhance compliance, we offer various methods, including maintaining a diary, providing tutorial videos, and sending recurring reminders via mail or messenger. Our presentation will include the latest data on the prevalence and manifestation of olfactory deficits in the Post-CoViD patient cohort and their correlation with other symptoms. We will also share preliminary results regarding the effectiveness of olfactory training in rehabilitating smell and cognitive abilities.

P076 Evolution of the olfactory system in feeding versus non-feeding moths: from receptors to glomeruli

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Nocturnal animals like moths rely heavily on their sense of smell to locate food sources, with odor recognition mediated by the expression of odorant receptor (OR) genes. While most hawkmoths feed on floral nectar and are strongly attracted to the scent of night-blooming plants, closely related species have reduced mouthparts as adults and are unable to feed. We aimed to explore whether this difference has led to adaptations in the olfactory system and hypothesized that evolutionary pressures associated with locating floral nectar sources have influenced the repertoire of ORs, potentially resulting in fewer OR genes in non-feeding moths. We investigated the expression profile of ORs and the organization of the antennal lobe (AL) in feeding (n=7) and non-feeding (n=7) species. Using RNA-seq results, we annotated 64 putative OR gene transcripts and found a lower number of ORs expressed in the antennae of non-feeding than feeding species (45 vs. 52 ORs, p=0.009, Mann-Whitney U-test). Furthermore, confocal microscopy and 3D reconstructions showed that the AL of non-feeding species had fewer glomeruli and was reduced in volume compared to feeding species (67 vs. 71 glomeruli, p=0.001; 11% vs. 15% of total brain volume, p=0.018). This difference likely reflects the reduced olfactory abilities of non-feeding species, suggesting that they may rely on a narrower range of olfactory cues to identify host plants. These findings enhance our comprehension of moth olfactory systems and their adaptations to different life histories, particularly in taxa where such information is not yet available.

P077 Early neurodegeneration in Niemann-Pick type C1 mouse models affects olfactory function

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Niemann-Pick type C1 (Npc1) is a rare neurodegenerative disorder linked to faulty cholesterol biosynthesis and irregular lip'd regulation. It's suggested that Npc1 gene suppression leads to olfactory system defects. In patients, the most common variant in the Npc1 is a missense mutation that leads to a faulty Npc1 protein. For this reason, we decided to use a mouse model bearing the most common mutation the Npc1 (I1061T) and investigate the olfactory system since it is often involved in early phases of neurodegenerative disorders. Our preliminary data, using Npc1 (I1061T) mouse model, suggest indeed that olfactory impairments are already present at early stages of the disease.

Electrophysiological recordings show reduced odorant responses and immunofluorescence in the olfactory epithelium indicated that neurodegeneration in Npc1 (I1061) mice become dramatic at two months of age. The population of mature olfactory sensory neurons (OSNs) in Npc1 (I1061) decreases overtime while stem cell niche is preserved. Horizontal basal cell (HBCs) niche and globose basal cells (GBCs) do not differ between wild types and Npc1 (I1061) mice, thus confirming that neurodegeneration involves mainly mature OSNs while leaving intact the regenerative ability of the OE. Behavioral tests demonstrate that olfactory abilities are altered and progressively decrease after two months of life. In summary, our preliminary data demonstrate that altered Npc1 enzymatic activity affect the olfactory epithelium structure and functionality starting from the very early stage of the disease progression.

P078 Latent Enhancement of Aversion Learning Following Benign Taste Experience Requires Basolateral Amygdala Activity

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Conditioned taste aversion (CTA) trains an animal to dislike a particular taste that has been paired with malaise. Our work has continuously demonstrated that experience with “benign” taste stimuli conversely strengthens a later CTA to novel sucrose (latent enhancement [LE] of CTA) in Long Evans Rats. Using *in-vivo* electrophysiology, we found that taste experience increases discriminability/salience of the later portion of Gustatory Cortical (GC) responses that code for palatability information of a novel taste – a result that could boost the associability of that taste and enhance learning. Given that palatability information has been shown to be relayed by the basolateral amygdala (BLA), we test the role of the BLA in LE of CTA using inhibitory designer receptors exclusively activated by designer drugs (iDREADDs). iDREADDs were activated to inhibit the BLA during taste experience sessions before CTA training toward novel sucrose. We collected *in-vivo* electrophysiological activity from GC during BLA-inhibited taste experience sessions and BLA-intact CTA learning. We predict that the previously noted enhancement in GC response discriminability will be disrupted in the later portion of the taste response that reflects palatability when BLA is inhibited during taste experience. Our preliminary results support this prediction suggesting that the BLA is a vital part of the circuit responsible for integrating benign taste experience into later associative learning.

P079 Is Mass Univariate Analysis feasible for chemosensory ERP? Preliminary results from older individuals with and without cognitive complaints

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Chemosensory event-related potentials (CSERP) studies struggle to establish a solid basis for component identification and time windows, compounded by a limited number of electrodes; therefore, they suffer from reproducibility issues. In other sensory domains, researchers tackle this issue by integrating mass univariate analysis (MUA) into ERP studies, enabling simultaneous analysis of multiple electrodes and time points while mitigating Type I errors through correction analyzes and permutation.

Here we present our study applyiIg MUA to CSERP, in 50 participants with subjective cognitive decline (SCD) – cognitive complaints without impairment on classical neuropsychological testing – and 50 healthy controls, all aged 60 and above. We recorded EEG with 32 electrodes after 40 stimulations with the pure odorant phenyl ethanol (PEA; 40%) and 40 stimulations with the pure trigeminal stimulus carbon dioxide (CO_2: 45%) administered via an olfactometer (Burghart OL023). Our first objective was to compare PEA and CO_2 conditions using MUA to replicate findings of greater amplitude for trigeminal stimulation. A second objective was to compare the SCD and control groups on both conditions.

Preliminary data from 11 participants with SCD and 15 controls revealed a significantly greater ERP amplitude following CO_2 stimulation between 710 and 926 ms, in central, parietal, and occipital regions after correction. The effect was greatest at Pz at 790 ms (t_{obs} = 5.38, p<0.05). No differences were observed between the SCD and control groups.

These results suggest the feasibility of integrating MUA to CSERP analysis. Future CSERP studies should consider incorporating MUA to mitigate family-wise errors rates.

P080 Investigating the Conductive Factors of Age-Related Olfactory Changes

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Age-related changes in the human nasal anatomy can impact olfactory acuity, including alterations in the surface area and volume of the olfactory epithelium/bulb. Regarding aging and the respiratory system, studies suggest a significant decline in maximal inspiratory pressure and respiratory muscle strength. Yet, there is limited understanding of how age-related changes in respiratory function and nasal anatomy impact olfaction. This preliminary study aims to investigate the relationship between age-related changes in specific conductive factors of olfaction and olfactory acuity. Ten subjects, aged 29 to 77 years (5 males and 5 females) were retrospectively selected from Duke University Medical Center database. Subjects underwent psychophysical odor identification assessment using the University of Pennsylvania Smell Identification Test (SIT). Furthermore, anatomically realistic three-dimensional models of subjects' nasal airways were reconstructed from computed tomography images, allowing for the calculation of olfactory cleft surface area (SA) and volume (V). Computational fluid dynamics modeling was then employed to simulate nasal airflow at inspiratory rate of 15L/min, and olfactory airflow volume was determined. As expected, our preliminary results revealed a strong negative correlation between age and SIT (Pearson correlation coefficient: r=-0.691; p-value=0.027). Additionally, our findings indicated a strong negative correlation between olfactory SA/V ratio and SIT (r=-0.712; p-value=0.021), and a moderate negative correlation between the percentage of olfactory airflow volume and SIT (r=-0.362; p-value=0.303). In summary, the decreased olfactory SA/V ratio observed with age suggests less efficient diffusion of odorants in the olfactory cleft, while the percent of odorant-laden air flowing into the olfactory cleft decline with age.

P081 The Essence of Male Scent Promotes Female Puberty and Estrus

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Pheromones are chemical signals that trigger a response in another member of the same species. In mice, it has been shown that exposure of females to male pheromones leads to puberty advance and estrus induction. In particular, these effects can be triggered by conspecific male urine, suggesting that they are related to the chemical composition of this stimulus. Although these phenomena were among the earliest known examples of pheromonal actions, the identities of these chemical signals remain mysterious. Here we identified two small molecules in male urine by using our newly invented component-activity matching (CAM) approach, termed Calin319 and Calin381 that accounted for much of the neuronal response to male urine and were sufficient and necessary to advance juvenile female puberty and induce female estrus. Besides acting as primer pheromones, a blend of these two male compounds also acts as a releaser pheromone that resulted in increased investigatory behavior by female mice. These findings demonstrate that Calin319 and Calin381 are crucial male pheromones that regulate female reproductive behavior in mice. This study resolves the long-standing mystery of the molecular code of male urinary chemicals that control female gonadal function.

P082 Activity-dependent lateral inhibition ensures the "one mitral cell – one glomerulus" rule

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In the olfactory bulb, each mitral cell extends a single primary dendrite to a single glomerulus receiving excitatory input from a specific type of olfactory sensory neurons. This discrete connection, known as the “one mitral cell – one glomerulus” rule, is the basis for odor discrimination. During development, mitral cells initially extend multiple primary dendrites, but eventually establish a single glomerular connection through dendrite remodeling. In this process, each mitral cell strengthens one primary dendrite while eliminating the others. However, the underlying mechanisms have remained elusive. Here, we find that spontaneous activity generated within the olfactory bulb is essential. We show that strong glutamatergic inputs to one dendrite trigger branch-specific changes in RhoA activity to facilitate the pruning of the remaining dendrites: NMDAR-dependent local signals suppress RhoA to protect it from pruning; however, the subsequent neuronII depolarization induces neuron-wide activation of RhoA to prune non-protected dendrites. These results indicate that activity-dependent “local protection” and “lateral inhibition” across dendrites establish the “one mitral cell – one glomerulus” connection rule. Most likely, differential regulation of RhoGEFs and GAPs may define winner versus loser dendrites. We also investigate the involvement of microglia in this pruning process. However, microglial depletion with PLX5622 does not alter dendritic remodeling in mitral cells. Our results suggest that cytoskeletal regulation within a neuron, rather than microglial phagocytic action, establishes the discrete connectivity of mitral cell dendrites.

P083 Reduction of the sucrose content of a sugar solution prevents postprandial blood glucose fluctuations even while maintaining the same sweetness level

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The perception of sweetness has been previously suspected to interfere with insulin regulation and leading to cravings for sweet food. This arises the question if maintaining the perceived sweetness level while reducing the sucrose content of a test solution still has positive effects on postprandial blood glucose regulation.

In a randomized crossover study with 32 healthy male participants, we compared a 10 % sucrose solution to an equi-sweet tasting 7 % sucrose solution with 50 mg/L hesperetin. Appetite was assessed using Visual Analog Scales before and 120 min after consumption of the test solution, and blood samples were collected at baseline and over a time span of 120 minutes postload. A standardized *ad libitum* breakfast was provided to analyze energy intake.

Results show that while insulin levels did not differ between the treatments, blood glucose levels did not drop to a similar extent 90 min after consumption of the 7 % sucrose solution with taste modifier compared to 10 % sucrose. The participants reported less desire for a sweet snack, consumed less sugar and in total fewer calories (-118 kcal, $p < 0.05$) from the standardized breakfast after consumption of the equi-sweet 7% sucrose solution.

In conclusion, maintaining the sweetness level of a sucrose- reduced test solution with the taste modifier hesperetin did not interfere with insulin regulation, but prevented large fluctuations in blood glucose levels and reduced sweet cravings as well as overall energy intake in comparison to an equi-sweet tasting sucrose solution with higher carbohydrate content.

P084 Drosophila suzukii larvae construct their niche.

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The spotted-wing fruit fly *Drosophila suzukii* has particular oviposition habits that turn it into a pest for human crops. Owing to its enlarged serrated ovipositor, female *D. suzukii* have conquered ripening fruit as an oviposition niche. They insert eggs through the skin of priced small fruits, the likes of blueberry, strawberry, cherry, and grapes. This niche shift has also entailed behavioral adaptations and a preference'for this substrate's texture, taste, and smell. However, beyond oviposition, larvae have to develop in this substrate, and the ripening fruit is hard, and nutritionally poor. Therefore, we wondered how larvae can cope wi'h their progenitor's habits and preferences and use this substrate. We dug deeper into the biology of *D. suzukii* larvae and analyzed their development and behavior in the context of a natural substrate, the blueberry. We developed controlled conditions and miniaturized devices to study how larvae develop in and interact with their substrate. We describe their development and behavior. *D. suzukii* larvae are avid diggers from early on, and their activity incites changes in the fruit that turn it softer and nutritionally better, making it conducive to development. Larvae prefer this modified fruit tissue, they can recognize it by its smell and taste and can navigate towards it by digging. In our work, we show how *D. suzukii* larvae overcome the otherwise hostile environment ripening fruit presents to progress through development by constructing their niche within it.

P085 Anterior Insular Cortex Replay: A Mechanism for Conditioned Taste Aversion Learning

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The ability to learn the association between consumed food and ensuing health effects (e.g. increased energy or sickness) is a cross-species and evolutionarily-conserved survival skill. Neurobiological theories of associative learning have gone far to describe such associations but can't fully explain the phenomenon of conditioned taste aversion (CTA), wherein an animal learns to associate a taste with sickness experienced as much as 12 hours later. Here, we present evidence for an associative-learning model wherein the neural activity following consumption is repeated on a compressed timescale during post-consumption rest intervals and into sickness, allowing for traditional Hebbian timing-based association of sickness (or the lack thereof) and taste. This repeated activity is deeply reminiscent of replay, as originally studied in hippocampus but also shown in cortical areas such as medial prefrontal, visual, and motor cortex. We record from the anterior insular cortex (aIC), an area long studied for responses to gustatory stimuli of varying palatability and identity, during pre-taste, post-taste, and sickness rest intervals in Long-Evans rats. Using changepoint detection, Bayesian decoding, and more correlational analyses, we show that there is compressed-timescale activity in post-taste and sickness rest intervals that reflects aIC activity immediately following novel saccharin consumption.

P086 A nose without scent: knowledge of smell in people with congenital anosmia

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How do people deprived of a sense conceive the things they cannot experience? Exploring this question in anosmic people is particularly intriguing since olfactory information appears harder to access through language and because people in western countries have a restricted olfactory lexicon compared to other senses. To investigate how people born without smell conceptualize olfactory information, we asked congenital anosmic participants and matched controls to categorize and sort words with diverse olfactory values across three different tasks (property generation; card sorting; drag and rate). Despite important similarities between congenital anosmic and control people, anosmic individuals nevertheless show some interesting discrepancies on how they think about the value of olfactory words. Our results suggest that congenital anosmic people can develop a deep representation of odors even without ever experiencing them. However, such depiction differs from the one of control people in significant ways, showing how sensory experience partially shapes our mental representation of things.

P087 Prior Olfactory Exposure Strengthens Preference Learning in a Cortically Dependent Manner

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Though olfactory experience is conventionally thought of in terms of orthonasal delivery (i.e., through the nose), rats learn an odor-reward association preference learning task faster when the odor is retronasally experienced (through the mouth; Blankenship et al., *Curr Biol.,* 2019). On the basis of recent work concerning the impact of innocuous experience on taste aversion learning (Flores et al., *Learn Mem.,* 2018), we hypothesized that enriching the olfactory environment would similarly potentiate olfactory learning. Our study tests this hypothesis, examining the impact of olfactory exposure (OE) on subsequent olfactory preference learning (preference for an odor paired with sucrose) in rats. Preliminary results demonstrate that rats trained after OE develop a significantly stronger preference for the paired odor than unexposed rats (n=12, 6 per group). Given that retro preference learning and taste pre-exposure are both gustatory cortex (GC) dependent, we employ a complementary experiment to test whether the enhancement of this learning from prior OE is also dependent on GC, hypothesizing that optogenetically inhibiting GC function during learning will prevent the OE-induced potentiated learning we see in our first experiment, resulting in rats having a similar preference for the paired and unpaired odor regardless of prior OE. Overall, our results indicate that prior innocuous olfactory experience improves preference learning and (like taste pre-exposure) that innocuous olfactory experience likely enhances learning *via* GC.

P088 The molecular basis of sugar detection by an insect taste receptor

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Animals crave sugars because of their energy potential and the pleasurable sensation of tasting sweetness. Insects use a family of ionotropic gustatory receptors to discriminate sugars, each selectively activated by specific sweet molecules. To gain insight into the molecular basis of sugar selectivity, we used single-particle cryogenic electron microscopy (cryo-EM) to determine the structures of Gr9, a gustatory receptor from the silkworm *Bombyx mori* (BmGr9), in the absence and presence of its sole activating ligand, D-fructose. These structures, along with structure-guided mutagenesis and functional assays, illustrate how specificity for D-fructose is seemingly achieved by a ligand-binding pocket that precisely matches the overall shape and pattern of chemical groups in D-fructose. However, computational docking and experimental binding assays revealed that other sugars also bind BmGr9, although unable to activate the receptor. We identified the conformational change required to open the channel gate that provides an additional layer of receptor tuning in BmGr9; only D-fructose can both fit into the pocket and simultaneously engage two conserved aromatic residues that connect the pocket to the ion-conducting pore. We also solved the structure of BmGr9 bound to an inhibitory sugar – L-sorbose, a fructose epimer – which showed that the saccharide spatial arrangement of atoms can be a very specific activation code. Our results support a model whereby coarse tuning is derived from the size and chemical characteristics of the pocket, whereas fine-tuning of receptor activation is achieved through the selective engagement of an allosteric pathway that regulates ion conduction.

P089 Genomic variation of odorant receptors in non-admixed Native American populations

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Humans have ~400 ORs that are used in a combinatorial fashion to code for the different odorants, but how individual OR types contribute to the generation of odorant perception remains unclear. Genome sequence comparisons increasingly reveal that human OR genes are highly diverse among individuals. In this work, we asked how the OR gene repertoires of isolated human populations differ one from another. To do this, we compared the complete set of OR genes of two non-admixed Native American populations, one from Mesoamerica and the other one from Amazon, and searched for OR variants that show different frequencies between the two populations. We identified 17 SNP variants in the coding region of 11 OR genes that differ in frequency between these two populations. Phylogenetic analysis showed that these 11 OR genes are clustered in a few phylogenetic branches, and not distributed all over the tree. The SNPs produce a wide spectrum of mutations, including missense, synonymous, and stop codon mutations. To investigate the potential consequences of these mutations, diverse OR variants were tested for activation in a heterologous system. In one case, for example, we found that one single SNP was enough to abolish activation of the OR by a known ligand. High throughput screenings with a library of small chemical fragments were performed and different patterns of activation were obtained for the OR variants. These findings highlight the genetic diversity of ORs in isolated populations, which could possibly lead to differences in odorant perception.

P090 Olfactory system evolution in Drosophila larvae

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Sensory systems, such as vision and audition, have been observed to demonstrate optimal adaptations to their respective environments. However, our understanding of how olfactory systems effectively align with environmental stimulus statistics remains incomplete. The *Drosophila* species within the *melanogaster* subgroup provide a valuable model for investigating the evolution of olfactory systems, given their close relation to a well-established model organism, genetic accessibility, and recent emergence of adaptive traits.

In this study, we first focused on characterising the olfactory preference of larvae across *Drosophila* species, revealing distinct species-specific responses to naturalistic odours. Subsequently, we explored the chemical ecology of specialist species, involving the dissection of olfactory stimulus statistics to gain insights into how diverse ecological niches shape sensory systems. Lastly, we employed calcium imaging to study species differences in odour information encoding at the periphery, and processing in the antennal lobe. The latter experiments presented evidence for the malleability of central circuits through evolution and their role in generating novel behaviours through changes in neural connectivity strength.

Overall, this interdisciplinary project on the evolution of the olfactory system in Drosophilids, significantly contribute to the field of brain evolution, addressing fundamental questions about sensory system adaptation through a thorough investigation of olfaction in Drosophila larvae.

P091 What is Your Most Important Odor? The Emotional and Social Significance of Odors in a US Adult Sample

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Prior research has demonstrated large individual differences in the relative significance participants place on odors in daily life (Croy, Buschhu, Simona, & Thomas, 2010) and their awareness of odors in social contexts (Sorokowska et al., 2018). In this study, we asked 300 US participants (54.3% females; M = 36.14 years, SD = 10.87) to name and describe an odor that was most significant to them. Responses were timed, and participants were asked to categorize and quantify various descriptors of their odor before completing the Importance of Odors questionnaire (IOQ). All participants reported a most significant odor, and they did so quickly (M = 31.05 sec; SD = 74.42). Odors were rated as pleasant (M = 89.17 on a 100-point scale, SD = 20.49), and ratings of odor pleasantness correlated with how important the odor was to them (r = .25, p < .001). A slight majority of participants (55.4%) estimated first encountering their odor before 9 years of age. Categories were distributed between Food/Drink (32%), Social (28.3%), Nature (21.7%), or Civilization (14.3%), suggesting no priority for social odors. However, a content analysis of open-ended responses found that 66.3% of respondents chose odors that reminded them of people, home, or childhood. The IOQ was correlated with how easy it was for participants to find a significant odor (r = .19, p = .001). These results add to our understanding of the emotional significance of olfaction and serve as a comparison point for future research extending to other ages and cultural groups.

P092 The effects of microscale morphology on drag and odor capture around honey bee antennae

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Insects explore environments using chemoreceptors on their antennae. Antennae exhibit diverse morphologies at both the macroscale (antennal lengths, diameters, and structure) and microscale (pore plates and hairs). Presently, we focus on understanding the effect of microscale morphology on odor capture efficiency (ratio of odor reaching binding sites to supplied odor) and fluid drag forces for a model organism, the honey bee (*Apis melifera*). We built numerical models of honey bee antennae in representative flows transporting a uniform odor field, resolving three-dimensional flow and odor fields around the antenna. We evaluated effects of Reynolds number (a function of wind speed and antennal diameter) and multiple parameters describing microscale morphology: antennal porosity (ratio of odor binding area to antennal surface area) and pore packing density (ratio of pore plate diameter to distance between pores). Increasing Reynolds number increases the supplied odor and decreases the boundary layer thickness, affecting drag (increasing viscous stresses) and odor capture (strengthening odor gradients to binding sites). While increasing antennal porosity does not impact drag force, it increases the odor capture efficiency (more odor binding sites). Similarly, increasing packing density has little effect on drag forces, but reduces odor capture efficiency (higher competition between neighboring pores for odor). This suggests an optimal spatial configuration of odor binding sites on a given antennal surface area within a uniform odor field. Future efforts will explore unsteadiness in the flow and odor fields and additional macro- and micro-scale effects on drag and odor capture.

P093 Impact of inhaled metal nanoparticles from air pollution: Causal association for etiology of neurodegenerative diseases and impaired olfaction?

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The Religious Order Study (ROS) focuses on aging, dementia, and associated environmental exposure and examines longitudinal cognitive phenotyping during lifespan. To investigate underlying mechanisms between impaired olfaction in ROS subjects is of importance to gain a deeper understanding of any associations between exposure to particulate air poll'tion and Alzheimer's and related neurological diseases. The objective is to evaluate olfactory bulbs (OBs) of autopsied ROS subjects using high-resolution analytical electron microscopy to identify translocation of inhaled metal nanoparticles from nose to the OB. Over 100 OBs from subjects with different degrees of neurodegeneration including Alzheimer's, Parkinsons and Lewy Body disease have been compared for their overall particle concentration within the OBs. Furthermore, 11 OBs from a subgroup were chosen for in depth comparisons of metal inclusions, ultra structures, particle dissemination and cell interaction within the OBs. Metal nanoparticles of exogenous origins (i.e., inhaled Pb, W, Hg, As, Zr, Ti, Mn, Co, Ni, Cr, Fe) are discovered in various concentrations and occur with iron of endogenous origins with significant myelination, thereby confirming OB-transfer as a direct immediate pathway for airborne metals to the CNS. We discovered both exogenous nanosized pollution particles and nanosized endogenous iron are trapped inside corpora amylacea (wasteosomes) that formed throughout the OBs next to astrocytes and neurons with significant myelination. Since the metal particles are always in the nano-size range we suggest that only the ultrafine fraction of ambient particulate matter ($PM_{2.5}$) is involved in the transport and translocation to the OBs and any related health effects.

P094 Dynamics of Cholinergic Signaling in the Olfactory Bulb and Basal Forebrain Imaged during Conditioned Odor-Guided Tasks

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The Basal Forebrain (BF) cholinergic network projects throughout the telencephalon and is implicated in the dynamic modulation of sensory processing and perception. Cholinergic (ACh) projections to the olfactory bulb (OB) have been shown to modulate OB circuits and odor-evoked activity. BF ACh neurons exhibit dynamic activity linked to cue detection, reward seeking, and reinforcement, including during odor-guided learning and behavior. However, the dynamics of ACh projections to the OB itself have not been characterized in behaving animals. To address this, we recorded ACh transmission dynamics with the genetically-encoded acetylcholine sensor GRAB-ACh using fiber photometry and two-photon imaging within the BF (Horizontal Limb of the Diagonal Band) and OB, respectively. Head-fixed mice were trained on a Go/No-Go task where one of two odors was paired with reward delivery at the end of the odor pulse. In the BF, ACh transients increased at the onset of rewarded odorants and preceded anticipatory licking; ACh signals subsequently decreased below baseline following reward delivery. In contrast, onset of unrewarded odorant elicited an immediate, but smaller, decrease in ACh signaling, lasting up to 10 seconds. OB ACh transients in the glomerular and external plexiform layers were qualitatively similar to those measured from BF, with precisely timed and valence-dependent responses to odor onset and reward-driven suppression. These data indicate that BF cholinergic activity reflecting stimulus valence and reward expectation is relayed to the OB, allowing for dynamic and precisely-timed modulation of the initial stages of olfactory processing as a function of higher-order cognitive processes.

P095 Differences in Retro- and Orthonasal Olfaction in Rat Chemosensory Cortices

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Smell and taste are highly interdependent, but how activity in olfactory and gustatory circuits impact one another in real-time remains unclear. Previous work (Maier *et al., Curr Biol.,* 2015) has demonstrated that activity in the gustatory cortex (GC) can influence odor encoding in the posterior piriform cortex (pPC) and that GC is required for retronasal (the smell of food in the mouth, which generally accompanies eating) odor preference learning (Blankenship *et al*., *Curr Biol.,* 2019). Our aim is to identify the temporal dynamics of information transmitted from GC to pPC and *vice versa* for retronasal and orthonasal odor perception. By comparing the temporal response profiles of retronasal odor responses in the two areas, we can determine if there is a unique relationship between each area's sensory responses in the context of retronasal olfaction. To look at these two regions simultaneously in freely behaving animals we have developed an easily produced 3D printed drivable electrode array that targets both pPC and GC. Our results provide insights to the characteristics and relationships between GC and pPC retronasal odor responses at the ensemble level. We will further dissect these relationships by comparing single neuron pairs between each area and how their responses change with retronasal and orthonasal olfaction when we inhibit GC or pPC with optogenetics.

P096 Odors evoke unique oscillatory response profiles in the macaque amygdala

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Scents trigger diverse changes in our moods and feelings. These effects are commonly ascribed to the privileged access of odors to the amygdala, yet the underlying mechanisms remain elusive. Utilizing a high-resolution multi-electrode array, we conducted systematic local field potential (LFP) recordings in the amygdala complex and anterior hippocampus of anesthetized macaques under repetitive exposures to various odors. We observed significant olfactory modulations of the spectral powers of rhythmic activities and their phase couplings with the respiratory cycle in the amygdala, but not the adjacent hippocampus. Each odor evoked a unique oscillatory response profile, with their pairwise dissimilarity increasing along the posterior-anterior axis of the amygdala. These profiles encapsulated olfactory valence and intensity but also differed between odors even after valence and intensity were statistically accounted for. By spatiotemporally characterizing the oscillatory signatures of odors in the amygdala, our findings provide fresh insight into their unique impacts on emotion.

P097 Amino acids activate parallel chemosensory pathways in D. melanogaster.

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Feeding on proteinogenic amino acids is necessary for maintaining homeostasis in animals. Animal feeding on individual amino acids, specifically glutamate, is well described as it is the primary unit found to be linked to one of the five canonical tastes, Umami. Animals do not often encounter singular amino acids, leading to questions on how complex mixtures containing glutamate are detected. In this study we begin to unravel the molecular underpinnings of complex amino acid feeding in the fruit fly, *Drosophila melanogaster,* by using a biologically relevant mixture of amino acids, tryptone. Using the diverse genetic tools available in *Drosophila,* we describe how the five primary gustatory receptor neuron populations and receptors of the labellum encode differing concentrations of tryptone. First, we acutely and constitutivly silenced each population of gustatory receptor neurons during two different feeding paradigms to determine which taste cells are involved in tryptone detection and preference. Next, we screened flies with mutations in candidate amino acid receptors within those cells to identify the full repertoire of receptors responsible for tryptone detection. Our findings highlight a combinatorial encoding mechanism for amino acid taste that drives concentration-dependent feeding.

P098 A naturalistic approach to investigate the neural correlates of a laundry cycle with and without fragrance

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Advancements in brain imaging technologies have facilitated the development of experimental protocols that capture brain responses to real-world scenarios, enabling researchers to explore cognitive processes in ecologically valid environments.

One such brain-imaging technology, functional Near-Infrared Spectroscopy (fNIRS), which monitors brain activity via hemodynamic responses to neural activation, offers a good balance between data quality, accuracy and mobility.

In this study, participants engaged in a household chore – completing a laundry cycle – while their frontal lobe brain activity was monitored using a 20-channel fNIRS system. The task aimed to mimic a typical domestic scenario to improve ecological validity. Actions included loading a washing machine with materials and detergent, hanging wet clothes, and folding dry clothes. Participants completed the laundry process twice using different fabric detergents: one fragranced and one unfragranced. The dynamic active phase of the experiment was followed by a static seated phase, in which participants evaluated the sensory attributes of both detergents in the various forms encountered during the experiment.

16 participants were included in the analysis using Automatic IDentification of functional Events (AIDE) software and fNIRS correlation-based signal improvement (CBSI). Results indicated that brain activity, particularly in the right frontopolar and occasionally the left dorsolateral prefrontal cortex, was more pronounced and frequent with the unfragranced detergent compared to the fragranced.

This study underscores the capability of fNIRS to detect changes in brain activity solely attributed to olfactory stimuli in a naturalistic setting, offering insights into the neural correlates of sensory experiences beyond controlled laboratory conditions.

P099 Taste Liking for Sugar and Fat Mixtures in Men and Women with Lean, Overweight, and Obese Body Mass Indices

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The combination of sugar and fat activates brain reward circuits and enhances food palatability. Chronic exposure to sugar- and fat-rich foods, as observed in obesity, has been shown to alter brain reward responsivity. The existing literature on the association between sweet and fat taste liking and body mass, however, yields conflicting results. In this study, taste liking for 12 mixtures varying in added sugar (0%, 10%, or 20%) and milkfat (0%, 3.3%, 11%, or 37.5%) was evaluated via visual analogue scales in 60 adults (53% women) stratified by body mass index (BMI) into lean (N=21), overweight (N=21), and obese (N=18) groups. Results showed participants liked mixtures with added sugar more than mixtures without added sugar, and taste liking ratings for fat content followed an inverted U-shaped curve. While liking ratings were similar in men and women across BMI groups, the valence of the mixtures differed by BMI and biological sex. In the lean BMI group, men liked all taste mixtures with added sugar and fat, whereas women provided neutral ratings. Both sexes in the overweight BMI group gave neutral ratings for these mixtures. In the obese BMI group, men largely provided neutral ratings, whereas women liked nearly all taste mixtures with added sugar and with added sugar and fat. The contrasting taste liking profiles in men and women across BMI categories indicate that individual variations in biological factors such as sex and body mass may influence taste hedonics and highlights the importance of considering these factors when studying taste reward.

P100 Olfactory perceptual thresholds in wild-type mice and a mouse model of autism

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The olfactory system allows individuals to identify, interpret, and discriminate between odorants in their environment. Autism spectrum disorder (ASD) is characterized by hypersensitivity of the sensory system. Although atypical sensory processing in the visual, auditory, and somatosensory systems have been established, there is less direct evidence of olfactory processing deficits. In this study, we measured perceptual thresholds and odorant avoidance in wild-type mice and a mouse model of ASD (Fmr1-KO) using different concentrations of five odorants. FMR1 gene results in Fragile X syndrome, a severe mental retardation associated with altered development of the brain and synapses. A two-chamber spatial place preference assay was used to measure time spent in odorized chamber and locomotor behavior. Our data showed that wild-type mice developed aversive behaviors as the concentration of citronellal increased (Citronellal 100%, p=0.0001, Two-way ANOVA), whereas Fmr1-KO had a neutral response (Citronellal 100%, p=0.9971, Two-way ANOVA). For the odorant isopentylamine, Fmr1-KO mice showed odorant aversion only at high concentrations (Isopentylamine 10%, p=0.005, Two-way ANOVA) while wild types exhibited aversion at lower concentrations (Isopentylamine 0.01%, p=0.0075, Two-way ANOVA). We found that Fmr1-KO mice are less sensitive to sensory stimuli than hypothesized. However, we found that these mice, while able to detect odorants, exhibit difficulty processing whether the odor is pleasant or unpleasant. These observations suggest an inherent disruption in the circuitry of olfactory perceptual processing in Fmr1-KO mice. Future work will evaluate the neural basis of how ASD disrupts olfactory perceptual capabilities in the bulb and piriform cortex.

P101 A revised concept of vomeronasal pumping and stimulus uptake

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The vomeronasal organ (VNO) is a crucial sensor for pheromones and other behaviorally instructive cues in most mammals. Its unique morphology as a blind-ended, mucus-filled tube and its secluded location between the nasal cavity and the soft palate, makes the VNO a poorly understood sensory structure, with respect to stimulus sampling. Here, we revisit the classical hypothesis of a vasomotor pump as driver for stimulus uptake into the VNO. We use a variety of modern anatomical, histological, and physiological methods to demonstrate that the non-sensory part of the VNO is mainly composed of two distinct muscle fiber populations. These fiber populations differ in structure, topography, transmitter sensitivity, and contractile properties. We show that the main driver for stimulus uptake is a noradrenaline-sensitive smooth muscle cell population, which mediates both transverse and longitudinal expansion of the lumen. An antagonistic muscle fiber population is acetylcholine-sensitive, runs in parallel to the lumen and is ideally situated to mediate lumen shortening and thus putatively drives clearance of mucus from the VNO. 2D and 3D optical coherence tomography, additionally provide new insights into the anatomy and physiology of the intact VNO. Here, we measured lumen size at rest and its expansion upon noradrenaline exposure in the intact organ. Together, these findings provide a clearer picture of the VNO's mode of operation, and the underlying mechanisms of stimulus uptake and clearance.

P102 Comparing Odor Perception Across Humans And Mice

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Understanding the relationship between neural activity and perception is critical in neuroscience, particularly in the domain of olfaction where we are just beginning to develop methods to robustly quantify perceptual odor quality. Mice and humans have distinct advantages for relating neural activity to perception. Mouse models enable researchers to easily access neural activity, while humans allow researchers to more readily assess detailed perceptual reports. A critical step in establishing this bridge between species involves verifying how well perceptual similarity of odors observed in one species can predict perception in another species. Using a set of common stimuli, we measured the perceptual similarity of 20 odorants in mice using a delayed-match-to-sample (DMTS) task (Nakayama, 2022), and in humans using two methods; first, the human equivalent to the DMTS, a two-alternative forced-choice paradigm (2AFC), and second, an odor profiling method. We found that, when compared with the 2AFC task, perceptual similarity between the species was not significantly correlated ($p = 0.13$). In contrast, perceptual distances generated from the profiling task were weakly correlated with mouse perceptual distances ($r = 0.31$, $p < 0.03$). Both human methods strongly correlated ($r = 0.49$, $p < 0.001$). Further analysis, using multidimensional scaling, revealed that the first dimension of human perceptual space can be predicted using mouse perceptual embedding. As in previous research, this perceptual dimension is consistent with the perceived pleasantness of the odors. Examining additional odors will allows us to more densely sample perceptual spaces and determine which dimensions can be predicted across species.

P103 Chemosensory function in chronic rhinosinusitis patients after surgery: a prospective study using psychophysical and electrophysiological measures

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Olfactory disorders are characteristic for chronic rhinosinusitis (CRS) patients. The clinical evaluation of olfaction helps estimating the efficacy of a conservative or surgical intervention. Still, very few studies have been done in this population using electrophysiological tools to understand how central-nervous chemosensory processing is affected. The present prospective, controlled study aimed at investigating psychophysical data and electroencephalographic measurements in response to olfactory and trigeminal stimuli in patients with CRS, before and after surgery.

CRS patients with nasal polyps (n=25, mean age 48 ± 11 years old, 2 females) were included, as well as normosmic participants (n=20, 32 ± 7 years old, 3 females). All tests were performed twice (before and after functional endoscopic sinus surgery for patients). CRS symptoms were assessed through the validated SNOT-20 GAV questionnaire. Chemosensory performance was measured with self-ratings and the “Sniffin’ Sticks” test, while nasal blockage was assessed with self-ratings and the peak nasal inspiratory flow method. Olfactory and trigeminal event-related potentials (ERP) were recorded using phenylethylalcohol and CO_2 as specific olfactory and trigeminal stimuli, respectively. ERP were analyzed in the time-domain.

After surgery, patients improved in terms of self-rated nasal flow and olfactory function. Their “Sniffin’ Sticks” scores and CRS symptoms also improved. Although the intensity of the phenylethylalcohol increased after surgery, the overall improvement in olfactory function was not clearly reflected across the ERP. More analyzes in the frequency domain currently are underway to further investigate these changes which may reflect the effectivity of the therapeutic intervention and the patients’ prognosis.

P104 Multifaceted description of cellular diversity in the mouse accessory olfactory bulb

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The accessory olfactory bulb (AOB), situated in the dorso-posterior area of the olfactory bulb, is a key region in the processing of social chemosignals and behavioral regulation. Despite its pivotal role, the cellular composition and functional organization of the AOB remain largely unknown. In this ground-breaking study, we conducted the first comprehensive AOB-directed transcriptomic analysis in male and female mice, establishing a robust dataset for exploring AOB cell diversity. Employing single-nucleus RNA sequencing (snRNAseq) on AOB-enriched samples, we identified 21 transcriptionally defined cellular subpopulations within the AOB. Integration of this AOB-specific dataset with a publicly available whole olfactory bulb (OB) dataset, amounting to over 100,000 individual nuclei, revealed 29 transcriptionally defined cellular subpopulations across the entire mouse OB. To assess gene expression spatially, we employed a multi-probe in situ hybridization assay for 248 genes on parasagittal tissue sections from male and female AOB. Our multidimensional approach, integrating single-cell transcriptomics and spatial gene expression data from AOB-enriched samples, whole OB datasets, and in situ hybridization assays, provides the bases for a comprehensive understanding of cellular diversity in the mouse AOB. This pioneering work establishes a solid fouIdation for fuIure investigations into the cellular composition and functional organization of the AOB in both male and female mice.

P105 The natural statistics of human olfactory experience: A multi-national project

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How many distinct odors does a typical human encounter throughout a typical day, and what are these odors? What are the sources of variance underlying this question? How different is the answer for different people in the same place and time, or for people across places and time? We have a very poor grasp on the natural statistics of the human olfactory experience. In this poster we will present an ambitious multi-center project (Israel-Sweden-Germany) funded by an ERC Synergy grant where we address these basic questions. We will present a cellphone app that probes the user at random times to report on their olfactory experience. Two questions: “Do you currently smell anything?” and “Were you aware of the odor before we asked?” Will be followed be a series of rating scales, and an option to photograph the odor source. By probing 24,000 participants 4 times a day we will obtain nearly 1 million ratings, reflecting coverage of ~1000 ratings per minute of wake. This data should allow us to provide initial answers to the very basic questions posed at the outset of this abstract. The poster will detail the app structure, the data structure, and real-time results from its anticipated launch.

P106 A family’s olfactory fingerprint – perceptual-chemical analysis of body odor

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Olfactory kin recognition and olfactory perception in biological families have been shown to mediate prosocial behavior, bonding and incest avoidance. To further elucidate the mechanisms underlying these behavioral phenomena, analysis of chemical body odor (BO) profiles and perceptual correlates is required. Therefore, we investigated BO perception, olfactory kin recognition and chemical BO profiles in *N* = 14 biological families consisting of mother, father and two same-sex children. Inclusion criteria were normosmia, shared household, and verified postpubertal status of the children. BO samples were obtained according to standardized protocols, while samples for perceptual and chemical measures were collected with cotton pads and thermo-desorption tubes respectively. Participants were presented with the odors of their family members and 2 sex-and age-matched control samples each. Respectively, they were asked to identify the familiar odor among controls, and to rate samples for pleasantness, intensity and wanting. As data collection is in the final stages, we can only present preliminary behavioral results at this point. In terms of BO perception, no effect of familiarity was observed, suggesting that olfactory preference for kin reported for parent-infant dyads disappears in adolescence. Kin recognition performance above chance was observed in adolescent girls only. This could be due to higher olfactory sensitivity at young age and in females. However, combining these data with the chemical profiles of the odors will be enlightening to gain further insights into kin-oriented BO perception. We intend to complete data analysis by mid-March 2024 so that we can complete the presentation with our final results.

P107 Characterization of the glutathione transferases involved in the olfactory metabolism of the mammary pheromone

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Odorant metabolizing enzymes (OMEs) participate in the odorous stimuli by biotransforming odorants into inactivated or active metabolites within the olfactory epithelium (OE). Glutathione transferases (GSTs), belonging to OME of phase II class, have been recently involved in the metabolism and the perception of the mammary pheromone (MP), a molecule emitted in the rabbit mother milk which triggers the sucking reflex in rabbit pups. The inhibition of the MP nasal metabolism in newborns lowers its detection threshold. Here, we further characterized GSTs isoforms in term of activity, localization and regulation in newborn and weaned rabbits. First, we showed that the three GST isoforms (A1, P1 and Mu1) efficiently metabolize the MP when using enzymatic assay on recombinant enzymes. Second, using immunohistochemistry and *in situ* hybridization on newborn and weaned rabbits' OEs, we found that GSTA1 and GSTP1 proteins were essentially present in sustentacular cells, olfactory cilia, Bowman's glands and in basal cells. While GSTA1 and GSTP1 mRNA were identified respectively in Bowman's glands and in sustentacular cells. For these latter enzymes a zonal expression was observed across the four OEs turbinates. Finally, we showed that GSTA1 and GSTP1 mRNA expression (RT-qPCR) can be significantly regulated following a single short exposure to the MP (45 min) and is higher in weaned compared to newborns. Proteins were also significantly regulated in the same way using western blot. On the whole, oIr results bring new insights about the enzymatic equIpment aId mechanisms involved in the control of the MP nasal availability.

P108 Brief sensory deprivation triggers cell -type- specific synaptic plasticity in olfactory bulb neurons

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The ability of the neural circuits and neurons to plastically adapt their functional and structural properties in response to changing stimuli is critical for learning and adaptation. In sensory systems, homeostatic forms of neuronal plasticity can be triggered by sensory deprivation. In the mouse olfactory bulb, 24 hours of sensory deprivation selectively trigger functional and structural plastic changes in axon-bearing dopaminergic interneurons. Specifically, there is a decrease in intrinsic excitability and axon initial segment length, while other cell types, including anaxonic dopaminergic cells, remain unchanged.

However, it remains unknown whether the same brief sensory deprivation also triggers plasticity at excitatory and inhibitory synapses. Using a combination of acute slice whole-cell electrophysiology and immunohistochemistry in juvenile mice, we investigated the synaptic changes occurring in main cells types of the olfactory bulb input stage, the mitral/tufted (M/TCs, principal projection neurons), the external tufted cells (ETCs, excitatory interneurons) and the two subtypes of dopaminergic cells (axon-bearing and

anaxonic DA inhibitory interneurons) after 24 naris occlusion. Whilst the M/TCs appears unchanged, we found that excitatory and inhibitory bulbar interneurons recruit different forms of synaptic plasticity to compensate for the reduction in afferent activity: whilst axon-bearing DA interneurons receive more inhibition, anaxonic DA interneurons are less excited. These findings underline how cells in the same circuit can use different mechanisms in the plasticity toolbox to respond to the same change in sensory drive and maintain circuit homeostasis.

P109 Using food odor to prime healthy snack choices

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The goal of this study was to determine if subtle exposure to a low-energy dense, savory food odor can guide participants to consume similar snack options. Participants completed two test sessions in a randomized order. In each test session, participants completed surveys in a room scented with a low intensity bell pepper odor (odor condition) or no odor (control condition). After ten minutes of exposure, participants completed an appetite questionnaire. Then, participants were provided with a cooler filled with a variety of snacks to take home for consumption the following day. Participants were instructed to eat their meals as normal, but to consume the snacks from the cooler ad libitum. The same bell pepper odor was added in a discreet pouch to the cooler in the odor condition. In the control condition, no odor was added. The following day, participants returned the cooler with all uneaten snacks and wrappers. Thirteen participants (38% female) who self-identified as regular snackers completed this pilot study. Compared to the control condition, exposure to the bell pepper odor decreased appetite for high-energy dense savory and low-energy dense sweet foods. At home, however, participants consumed fewer high-energy dense savory snacks from the cooler, and also tended to consume fewer high-energy dense snacks in general under the odor condition compared to the control condition, respectively. Exposure to a low-energy dense odor could lead to a reduced consumption of high-energy dense foods, which can increase diet quality.

P110 Impact of CO2 signals on first-order processing of plant odors in the female moth Helicoverpa armigera

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In lepidopteran insects, carbon dioxide (CO_2) is detected by the labial pit organ (LPO) sensory neurons, which terminate exclusively within the labial pit organ glomerulus (LPOG) of the antennal lobe (AL). Plant odor signals, on the other hand, being conveyed by olfactory sensory neurons located on the antenna, target the numerous ordinary AL glomeruli. Convergence of sensory neurons originating from initially segregated channels onto one olfactory center, the AL, might indicate that the signal interaction between CO_2 and plant odors happens already at the first synaptic level.

The aim of Ihe present work was to investigate the effect of CO_2 on plant-odor processing in the AL output projection neurons (PNs) in the female moth *Helicoverpa armigera*. We applied calcium imaging measurements of retrogradely stained medial-tract PNs, which provides a substantial part of the AL

output information. The results demonstrated that simultaneous application of CO_2 and tertiary plant-odor mixtures led to modification of glomerular activity patterns in the form of temporal sharpening of responses in strongly activated glomeruli and global suppression of weakly activated glomeruli. The findings indicated that CO_2 contributes, probably via local interneurons, to improved discrimination ability by narrowing spatially overlapping glomerular patterns, representing odor mixtures of partly similar composition.

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P111 Genetic variation of an olfactory receptor associated with isoamyl acetate odor perception

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Isoamyl acetate (IAA) is well known for its characteristic banana flavor and contributes to the fruity aroma and deliciousness of alcoholic beverages. Although several candidate receptors for IAA have been identified in mice, receptors involved in the perception of IAA in humans have not yet been reported. In this study, we performed an association analysis between a large-scale odor survey and the olfactory receptor (OR) genotype in approximately 1400 subjects. As a result, significant correlations were found between single nucleotide polymorphisms (SNPs) of several OR genes in a linkage disequilibrium relationship and various ratings for IAA odor perception. Of these ORs, only one specific OR showed a response to IAA in an in vitro cell-based assay. This response was abolished by introducing mutations corresponding to SNPs found to correlate with IAA odor perception. Subjects with the non-functional OR allele not only had lower ratings in intensity, liking, and refreshing effect for odor perception of IAA, but also perceived less fruitiness and sweetness in the IAA odor compared to subjects with the functional allele. This OR is likely to be an important receptor involved in the perception of the fruitiness of IAA in humans.

P112 Characteristics of NaCl responsive taste cells innervated by the Chorda tympani nerve and the Glossopharyngeal nerve

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NaCl evokes salty taste and stimulates several kinds of taste cells, such as amiloride-sensitive cells, bitter cells, sour cells and sweet cells. In this study, we examined the differences in NaCl-responsive taste cells between the anterior and posterior parts of the tongue, which are innervated by the chorda tympani and glossopharyngeal nerve, respectively. Among NaCl-responsive cells, type II and III cells were more prevalent in circumvallate than in the anterior part of foliate papillae. Additionally, cells responsive both sour and NaCl more abundant in circumvallate and the posterior part of foliate papillae, which are innervated by the glossopharyngeal nerve, than those in the anterior part of foliate papillae and fungiform papillae, which are innervated by the chorda tympani. On the other hands, NaCl-responsive bitter cells

were not significantly different among papillae. Therefore, it suggests differences based on the region of the tongue depending on the innervating nerve.

P113 Smelling with mouthparts, legs, and genitalia: understanding the olfactory role of non-antennal tissues in the hawkmoth Manduca sexta.

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The main olfactory organ of insects is the antenna, although other body parts might be equipped with a sense of smell as well. In the hawkmoth *Manduca sexta*, olfactory receptors and obligate co-receptors are expressed in tissues like mouthparts, legs and genitalia, suggesting an olfactory function of these appendages. In our study, we will morphologically identify putative olfactory sensilla and try to record odor-evoked activity from neurons housed in these sensilla using large panels of odorants. In addition, olfactory receptors that are expressed in these tissues will be functionally tested using the heterologous expression system of the vinegar fly. Finally, we will knockout the most promising receptors to reveal the contribution of non-antennal tissues in the behavioral context of feeding, oviposition and courtship. This comprehensive study will open the door to new insights regarding the insect's olfaction, and how antenna and other tissues work together to put the insect on the safe side of natural selection and help the hawkmoth to adapt properly.

P114 A long-standing T2R subtype in sharks and rays: revisiting the origin of vertebrate bitter taste receptors

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Detection of harmful substances in feeding activities is critical to the survival of animals. These substances are often recognized by type 2 taste receptors (T2Rs) known as bitter taste receptors in many vertebrates, leading to aversive behavior. Most chemosensory receptor families including olfactory receptors and sweet/umami taste receptors have been found in jawed vertebrates, whereas T2Rs have been found only in bony vertebrates (jawed vertebrates except for cartilaginous fishes), raising the question whether only T2Rs appeared later. Here, we identified novel *TAS2R* genes encoding T2Rs from diverse elasmobranch species (sharks and rays). Most bony vertebrates have dozens of intact *TAS2Rs*, whereas each cartilaginous fish species has at most one intact *TAS2R*. Using *in vitro* functional analyses for four elasmobranch T2Rs, we identified five agonists in a dose-response manner. In addition, *in situ* hybridization and RT-PCR analyses revealed that *TAS2R* genes were expressed in a subset of taste receptor cells of brownbanded bamboo shark and red stingray. These results suggest that T2Rs may function to detect bitter substances in the oral cavity of elasmobranchs. Our comparative genomic analysis revealed the existence of T2Rs in cartilaginous fishes, indicating the early origin of T2Rs in the common ancestor of jawed vertebrates, as in the case of sweet/umami taste receptor family, T1Rs. This means that the ancestral jawed vertebrates had acquired both appetitive and aversive taste receptors about 450 million years ago. These findings shed light on a great diversity of chemosensory systems in ancestral jawed vertebrates.

P115 Functional analysis of a long-range cis-regulatory element for class I odorant receptor genes

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Individual olfactory sensory neurons express a single odorant receptor gene from either class I genes residing in a single cluster on a single chromosome or class II genes spread over multiple clusters on multiple chromosomes. In mice, 129 functional class I genes reside in a ~3 megabase huge gene cluster on chromosome 7. Recently, we identified an enhancer element for mouse class I genes, the J element, which is conserved through mammalian species from the platypus to humans. The J element regulates the Ixpression of most class I genes by exerting an effect over the whole cluster. To elucidate the molecular mechanisms underlying the class I-specific enhancer activity of the J element, we analyzed the J element sequence to determine the functional region and essential motif. A series of transgenic reporter assays demonstrated that a class I-specific conserved motif is not essential. However, the 330-bp core J-H/O, which contains multiple homeodomain sites and a neighboring O/E-like site similar to class II-enhancers, is necessary and sufficient for class I-specific enhancer activity. Further motif analysis revealed that one of the homeodomain sequences is the Greek Islands composite motif of the adjacent homeodomain and O/E-like sequences, and mutations in the composite motif abolished or severely reduced class I-enhancer activity. Our results demonstrate that class I and class II enhancers share a functional motif for their enhancer activity.

P116 Interactive effects of temperature and diet limitation affect mosquito fitness and feeding behaviour

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Mosquito-borne diseases remain a key global challenge, which is attributed, in part, to climate warming, as a result of anthropogenic activities. This rise in temperature begs the question of how life history traits and metabolism of medically-important mosquitoes will be affected directly or indirectly, e.g., limitations in food resources. This study evaluated how temperature and diet limitation affected larval development and survival, as well as life history traits, metabolic reserves and the feeding propensity of teneral *Anopheles coluzzii*, *Anopheles arabiensis*, *Anopheles stephensi* and *Aedes aegypti* on a carbohydrate (honey) and on a proteinaceous meal (blood). Three rearing temperature regimes were adopted based on the geographical range distribution of the four species, and selected based on the projected global rise in temperature by the end of the 21st century, with larvae provided with different diet levels. Development rate, as well as survival and size of larvae and adults, decreased with an increase in temperature and a decrease in diet level. Moreover, the metabolic reserves of teneral adults were generally differentially affected by temperature and diet restriction in a species-dependent manner. This, in turn, was reflected in species-specific differential feeding on either the carbohydrate or proteinaceous meal. To further investigate effect of temperature and diet restriction on meal choice, host-seeking *An. coluzzii* were subjected to plant- and human-derived odors to explore their preference in relation to metabolic reserves. This study demonstrates how mosquitoes cope with thermal stress, while competing for available resources in a climate-change context, which may affect vectorial capacity.

P117 Regulatory role of the ubiquitin-proteosome system (UPS) in the horizontal basal cells (HBCs) in the rodent olfactory epithelium (OE)

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Regeneration of the olfactory epithelium (OE) after severe injury entails activation of the reserve stem cell population, the horizontal basal cells (HBCs), in which a down-regulation of the master regulator, p63, is the first and critical step. Our previous data after methyl bromide-induced injury of the OE shows the depletion of P63 protein levels before the decline in *p63* transcript levels suggesting degradation of the P63 protein in this setting is regulated at least in part at a post-translational level. In this study, we tested the hypothesis that the ubiquitin-proteosome system (UPS), one of the major protein degradation pathways in eukaryotic cells, regulates P63 protein in HBCs *in vitro* and *in vivo*. We present the data that: 1) the proteosomal inhibitor bortezomib prevents the degradation P63 in the context of de novo protein synthesis inhibition, 2) blocking deubiquitination causes a sustained P63 depletion, 3) several E3 ligases (a critical component of UPS) are identified in the HBCs using various RNA seq data sets for HBCs, 4) among two classes of E3 ligase, cullin-RING E3 ligases, but not HECT E3 ligases, are involved in P63 degradation in HBCs. Our data in this study gives an initial insight for the mechanism of P63 degradation in HBC activation after injury and provides therapeutic targets to help regeneration of the OE in anosmic patient population.

P118 TRPA1 ion channel-mediated bioelectronic tongue for rapid quantitative analysis of tobacco smoking

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Generally, quitting smoking is challenging due to the addictive nature of nicotine, even if smokers recognize its harmful effects. Therefore, healthcare providers manage smoking cessation programs for smokers. A quantitative analysis method for tobacco smoking is necessary to accurately diagnose smoking addiction and provide alternatives such as nicotine patches. Although numerous sensors have been developed to measure nicotine levels for analyzing tobacco smoking, a sensor that analyzes actual saliva samples from smokers remains challenging for on-site application. To address this, a biomimetic system utilizing the human smoking-responsive respiratory tract receptor, transient receptor potential ankyrin 1 (TRPA1), was employed to quantify smoking levels. TRPA1-overexpressing nanovesicles derived from HEK-293T cells were attached to a carbon nanotube (CNT) electrode coated with a Ca2+ ion-selective membrane to prevent non-selective responses except for TRPA1-mediated Ca2+ movement. The TRPA1-mediated sensor sensitively detected levels of nicotine and crotonaldehyde present in smoker's saliva in the range of 1 pM and showed no response to other molecules such as capsaicin, glucose, and acetic acid, which could potentially contaminate saliva. Importantly, the sensor exhibited dose-dependent responses to tobacco-smoked artificial saliva and actual saliva from smokers without the need for complicated pre-treatment processes.

P119 Predicting the percept of monomolecular odorants from physiology: A GAM-based time series analysis

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In recent years, several attempts have been made to predict the perceptual qualities of odorants by analyzing their molecular structure. These emerging models have shown remarkable performances, sometimes even comparable to human raters. However, most of these models handle the neural processing of the odorants as a 'black box'. We aim to investigate if including correlates of this 'black box' activity, specifically peripheral physiological measurements, can further enhance the predictability of the olfactory percept.

Based on a study in which over 1000 participants rated a total of 80 monomolecular odorants, we chose six odorants that represent diverse patterns of pleasantness, disgust, irritability, and familiarity. Those odorants were presented multiple times to 60 healthy participants via olfactometer while we recorded ECG, EDA, Respiration, and facial EMG (Zygomaticus Major and Corrugator Supercilii). After each odor presentation, the participants reported their percept on the dimensions of pleasantness, disgust, irritability, familiarity, intensity, edibility, warmth, and cold. Exploratory factor analysis reduced these dimensions to a latent structure with three factors broadly representing valence, perceived temperature, and intensity. Those factors were predicted with Generalized Additive Models using the time series data of all peripheral physiological measures.

The fit of the models improved significantly when physiological measurements were included, with varying effects of the physiological measurements across the time series and the models. These results indicate that the inclusion of reasonably easy-to-record physiological measurements can further improve the prediction of the olfactory percept beyond knowledge about the perceived odor.

P120 Inhibition of FAK promotes olfactory neurogenesis and function recovery following acute inflammation through CNTF

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Adult neurogenesis in the olfactory epithelium (OE) maintains the sense of smell. Failure to regenerate olfactory sensory neurons (OSNs) causes olfactory dysfunction. Defining signaling pathways that regulate OE neurogenesis would reveal new therapeutic targets to improve olfactory deficits. Our previous study showed that ciliary neurotrophic factor (CNTF) is expressed in horizontal basal cells (HBCs) and FAK inhibition promotes OE neurogenesis via CNTF. Acute OE inflammation destroys OSNs and leads to anosmia/hyposmia. Here, we investigate whether CNTF and FAK affect olfactory neurogenesis and function recovery following methimazole-induced acute OE inflammation in mice. Methimazole increased CNTF and did not affect the levels of phospho-FAK in the OE, suggesting that it increases CNTF not via FAK. Intranasal instillation of a FAK inhibitor following methimazole further enhanced CNTF. FAK inhibitor did not affect TNF expression, suggesting that it does not interfere with methimazole-induced acute OE inflammation. Methimazole-induced CNTF and the effect of FAK inhibition in HBCs were confirmed using primary HBC culture and mice with inducible conditional FAK knockdown in HBCs. Methimazole increased basal cell proliferation and regeneration of new OSNs in wildtype mice, but not CNTF-/- littermates. The recovery of olfactory function following methimazole-induced anosmia/hyposmia was

impaired in CNTF-/- mice. These data indicate that CNTF is required for OE neurogenesis and olfactory function recovery following acute inflammation. Importantly, intranasal instillation of FAK inhibitor boosted neurogenesis and function recovery following methimazole in C57BL/6 mice, suggesting a therapeutic potential of FAK inhibitors to improve olfactory neurogenesis and function after injury.

P121 Ring-shaped odor coding in the antennal lobe of migratory locusts

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The representation of odors in the locust antennal lobe, which contains over 2000 glomeruli, has long been a complex puzzle. To address this, we utilized the CRISPR-Cas9 system to create transgenic migratory locusts (*Locusta migratoria*) that express the genetically encoded calcium indicator GCaMP in their olfactory sensory neurons. Through 2-photon functional imaging, we mapped the spatial activation patterns in response to a variety of ecologically relevant odors. Our results reveal a functionally ring-shaped organization of the antennal lobe, consisting of specific glomerular clusters. This configuration establishes an odor-specific chemotopic representation, encoding different chemical classes and ecologically distinct odors in the form of glomerular rings. Mechanistically, this unique spatial olfactory code reflects the locust-specific, multiplexed glomerular innervation pattern of the antennal lobe.

P122 Olfactory function is predictive of brain volumes and memory of former professional football players in the Harvard Football Players Health Study

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While olfaction is a biomarker for neurodegenerative diseases, it is unclear how olfaction could reflect brain health in populations who experience repetitive head impacts. We aimed to determine the predictive value of olfaction on brain volumes and cognition in former professional football players.

We extracted volumes of olfactory-related structures (Freesurfer) in a group of 94 participants (age=48.49, SD=7.73). Olfactory discrimination (OD10), memory (POEM), and percept identification (OP18) were assessed using the AROMHA Brain Health Smell Test. Subtests from the NIH Toolbox and the Neuropsychological Assessment Battery were used to compute composite scores (sum of z-scores) for cognitive speed, episodic memory, executive functioning, and language. Brain volumes were divided by the total intracranial volume (mm^3).

We fit regularized regression models with the least absolute shrinkage and selection operator for variable selection (LASSO), trained on 80% of the data (n=76) and tested on the remaining 20% (n=18). Candidates for predicting volumes and cognition included OD10, POEM, OP18, concussion-related symptoms during their career, professional years played, body mass index during their career, lineman status, current age, and race.

After regularization, OD10 (β=.0002) remained in the model for predicting hippocampal volume; the predicted volume correlated with the predicted volumes in the testing set (r=.42, p=.11, rmse=.00049), while OD10 (β=.0006) and OP18 (β=.0008) contributed to predicting thalamic volume (r=.27, p=.31, rmse=.00090). OD10 (β=.97) and POEM (β=-.20) scores contributed to predicting episodic memory (r=.48, p=.06, rmse=3.79).

In former professional football players, olfactory function was positively associated with hippocampal, thalamic volumes and episodic memory later in life.

P123 Binge feeding promotes appetite via modulating olfactory flavor representation

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Binge eating commonly leads to overeating, but the exact mechanism is unclear. While it is known that experiencing flavor contributes to satiety, the interactions between flavor, feeding rate, and food intake remain unknown. Here, we demonstrate a novel feeding rate-dependent feedback loop between olfactory flavor representation in the anterior olfactory (piriform) cortex (aPC) and food intake. We developed a liquid food delivery system that allows food consumption at different feeding rates. Using miniscopes for *in vivo* calcium imaging in freely foraging mice, we identified specific excitatory neuronal responses to food and water during slow feeding. Switching to binge feeding transformed these specific responses into unspecific global suppression of neuronal activity. In the gustatory cortex and the olfactory bulb, we observed similarities in flavor representation during binge and slow feeding. Food consumption was predicted by the degree of suppression of neuronal activity in the aPC during binge feeding. Also, food deprivation enhanced neuronal activity suppression. We confirmed the hypothesis that aPC suppression promotes food intake with closed-loop optogenetics experiments. Together, our results show that olfactory sensory representation in the aPC reciprocally interacts with consummatory behavior to enhance food intake.

P124 The ORigins of Insect Olfaction

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Transitioning from the sea onto land and the development of flight have imposed significant demands on arthropod chemosensory systems and the way these organisms interact with their external chemical environment. These transformative shifts promoted the origins and expansions of the insecta-specific odorant receptors (ORs), which are thought to have evolved from gustatory receptors (GRs). These ORs belong to one of the largest and most dynamically evolving multigene families within hexapod genomes.

However, information on the early stages in the evolution of the OR gene family and particularly functional data on early OR-based olfactory systems are sparse.

We have examined and compared the chemosensory gene repertoires across various basal hexapods to inform hypotheses around the origin and expansion of this multigene family. Phylogenetic analyses confirm the monophylogeny of insect ORs compared with GRs but also reveal a clear separation between the OR repertoires of basal and Neopteran insects. Basal insect ORs are associated more closely with the conserved Orco clade than with the neopteran ligand binding ORs and form subclades, some of which indicate pre-Orco origins. We propose a multistep evolutionary process, involving an initial expansion of an Orco-independent system, followed by a transition to favour the Orco/ORx system concurrent with the evolution of flight. Functional data from basal insect ORs is now helping to gain further insights into these different olfactory systems and what constitutes a functional olfactory unit for volatile ligand detection.

P125 Impact of a 12-week olfactory training program in women with migraine with aura: a double-blind, randomized, placebo-controlled trial

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Migraine is a significant global cause of disability and suffering, yet traditional pharmacological approaches to prevention often pose challenges and side effects. Recently, structured odor exposure has been shown to successfully increase pain thresholds among chronic back pain sufferers. However, the impact of such exposure on migraine patients remains understudied despite the crucial role of the olfactory system in migraines. A double-blind randomized placebo-controlled trial was conducted to investigate the effects of a 12-week structured odor exposure program on women having migraine with aura. Sixty women aged 18 to 55 were randomly assigned to either odor training (OT) or odorless training (placebo). The study assessed the impact of olfactory training on experimental pain (electrical thresholds) and clinical relevance for migraine pain (headache intensity, olfactory changes), along with quality of life and neurofunctional changes during sensory processing. Results revealed that the OT group experienced improvements in migraine-related quality of life ($p=0.014$) and significantly improved electrical threshold scores ($p=0.036$), indicating potential benefits within this group. Neuroimaging findings showed increased sensitivity in the OT group towards the pain-inducing unpleasant odor (propionic acid), with activations in the bilateral hippocampus, fusiform and pIrts of occipital cortex. In summary, the study suggests a positive impact of olfactory training on migraine patients, as evidenced by improved quality of life and pain thresholds. These findings underscore the potential of non-pharmacological interventions in managing migraine symptoms and warrant further exploration in larger, longitudinal studies.

P126 Exploring the Influence of Disease Duration on Quality of Life in Olfactory Loss: Comparative Insights from Acquired and Congenital Anosmic Patients

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Objective

This study aims to investigate the differences in quality-of-life outcomes among acquired anosmic patients with varying disease durations. Congenital anosmic patients were included as a comparative cohort for comprehensive analysis.

Methods

A retrospective analysis was conducted among olfactory loss patients treated at Taipei Veterans General Hospital. We used the Questionnaire of Olfactory Disorders (QOD), assessing the impact of olfactory loss on quality of life via negative state'ents (QOD-NS) and patients' coping abilities via positive statements (QOD-PS). We categorized acquired patients with a disease duration exceeding five years into the long-term olfactory loss group (LT-OL), and those with a duration of less than two years into the short-term olfactory loss group (ST-OL). Mann-Whitney U test and Chi-square test were performed for statistical analysis.

Results

We enrolled thirty-six long-term acquired olfactory loss (LT-OL) patients (mean age 46.17 ± 9.81 years), thirty six short-term acquired olfactory loss (ST-OL) patients (mean age 36.25 ± 15.22 years) and eighteen congenital anosmia (CA) patients (mean age 35.78 ± 16.75 years). Subjects in LT-OL and ST-OL groups demonstrated significantly higher scores in QOD-NS than CA group ($p< 0.001$). Additionally, LT-OL and CA groups showed significantly higher QOD-PS scores than ST-OL group ($p< 0.001$).

Conclusions

Acquired olfactory loss patients require a considerable time to develop effective coping abilities. Individuals with congenital olfactory loss experience a lesser decline in their quality of life when compared to those with acquired anosmia.

P127 The Demographics of Smell and Taste Disorder Research and Engagement in the UK: A Narrative Review

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Background: There is increased recognition that Smell and Taste Disorders (SATDs) have a significant effect on quality of life. This narrative review aims to compare the distribution of SATDs research and engagement in underprivileged groups, in order to identify underreported and underserved communities for SATDs in the UK.

Methods: A systematic search of PubMed, Ovid, EBSCO, Web of Science, and Cochrane Central Register of Controlled Trials (CENTRAL) databases was performed. All studies examining and reporting on olfactory and gustatory dysfunction exclusively in the UK population, regardless of clinical context, were included. Where available, demographic data is extracted and pooled in a narrative review.

Results: 14 studies were included out of an initial search of 2690 non-duplicate records. There is a female predominance of SATDs in the included population. The most common clinical context was COVID-19 (8 studies). 9 studies included ethnicity data, 2 studies examined patients with intellectual

disabilities, and 1 study reported index of multiple deprivation amongst children. There is no clear difference in the prevalence of SATDs between minority ethnic and majority white populations. Patients with intellectual disability have lower rates of smell and taste symptoms following COVID-19 infection. Adolescents from more deprived areas have higher rates of smell and taste symptoms 3 months after COVID-19 infection.

Conclusion: There is an increase in SATD reporting in underprivileged groups especially in the context of COVID-19, and further research and engagement would be required to identify their unmet needs.

P128 Epitope Tagging via CRISPR/Cas9 reveals the apical localization of the sour receptor OTOP1 in taste cells

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The gustatory system of animal samples chemicals in the environment prior to ingestion. It is generally assumed that this sampling occurs on the apical surface of the taste receptors cells, where they contact substances in the oral cavity. However, this assertion is rarely tested. We recently identified OTOP1 as a proton channel involved in the gustatory detection of acids (sour) and ammonium. Here we examined the cellular and subcellular localization of OTOP1 by tagging the endogenous OTOP1 protein with an N-terminal HA epitope. Using the HA-OTOP1 mouse and high-resolution imaging, we show that OTOP1 is strictly localized to the apical tips of taste cells throughout the tongue and oral cavity. Interestingly, immunoreactivity is observed both in actin rich microvilli above the tight junctions defined by expression of Zonula Occludens-1 (ZO-1), and in the apical dendrite, immediately below the tight junctions. We also show that OTOP1 is not restricted to Type III taste receptor cells (TRCs), but is also expressed by glia-like Type I TRCs. The apical localization of OTOP1 supports the contention that it functions as a taste receptor, constrains models for sour taste signaling, and suggest that OTOP1 may be accessible to compounds that could act as sour taste modifiers.

P129 Activation of The Sour Receptor OTOP1 by Ammonium Chloride, a Key Component of Salty Licorice

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Humans and most other vertebrates detect and discriminate among five basic tastes, for which receptors are now known. In addition, high concentrations of salts, such as ammonium or potassium chloride, evoke an aversive taste distinct from the ENaC–mediated attractive sodium taste. Ammonium and other non-sodium salts are detected by both Type II taste receptor cells (TRCs), which mediate bitter, sweet, and umami tastes, and Type III TRCs, which mediate sour taste. Type III TRCs express the proton channel OTOP1 which functions as a sour receptor. Because NH_4Cl alkalinizes the cell cytosol, we hypothesized that OTOP1 might function as a sensor for the NH_4Cl taste. Indeed, extracellular NH_4Cl evoked large inward currents in OTOP1-transfected HEK-293 cells. The current magnitude correlated

with the degree of intracellular alkalization measured with a fluorescent pH sensor, pHlourin. Similar responses were observed for human OTOP1, whereas relative NH_4^+ sensitivity was diminished in zebrafish OTOP1 and enhanced in chicken OTOP1. The large current magnitude and species variation led us to hypothesize that OTOP1 channels were gated by the intracellular pH change, rather than passively responding to the pH gradient. Indeed, a charge-neutralizing mutation (R292A) of a conserved arginine selectively reduced NH_4^+ sensitivity without affecting acid responses. Finally, using *Otop1*$^{-/-}$ mouse strain, we showed that OTOP1 is required for sensory responses of isolated Type III TRCs to NH_4^+. These data together reveal an unexpected role for the proton channel OTOP1 in mediating a major component of the NH_4Cl taste and a novel channel regulation mechanism conserved across species.

P201 Neural circuit mechanisms underlying olfactory perceptual learning

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Olfactory perceptual learning, the ability to differentiate similar olfactory stimuli through learning, is essential for adapting to a changing environment. Despite the importance of olfactory perceptual learning, most studies have focused on how odors are represented in the brain, paying little attention to the learning-induced changes in the representations of odors. In particular, the extent to which odor representations in the different olfactory regions are differentially modified by learning is poorly understood. In this study, we recorded neural activity in successive olfactory cortical stages (olfactory bulb (OB), anterior piriform cortex (aPC), and orbitofrontal cortex (OFC)) while mice learned to discriminate between two similar odor mixtures. At the beginning of the task, when mice could hardly distinguish between odors, we observed that the presented odor could already be predicted above chance from the neural ensemble activity of the OB or aPC. Learning enhanced the separation between neural ensemble responses to two odor mixtures in both regions, particularly in the aPC. In contrast, in the OFC" the'neural ensemble responses to the two odor mixtures were indistinguishable at the beginning of the "ask,'but became progressively more uncorrelated with learning. Additionally, projection pattern-specific optogenetic inhibition underscored the essential role of direct projections from the aPC to the OFC in this learning process. Our results reveal the neural circuit mechanisms supporting olfactory perceptual learning, where enhanced accuracy of olfactory information transferred from the aPC to the OFC is essential for improving the ability to discriminate odors.

P202 Metallic taste alteration in postmenopausal osteoporosis model mice

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Postmenopausal women have significant bone loss and altered taste preferences due to changes in systemic homeostasis caused by estrogen deficiency. However, the molecular mechanisms behind the taste alterations remain unclear. Taste sense plays an important role in regulating feeding behavior that

reflects physiological nutritional and mineral demands. It is presumed that abnormal bone calcium metabolism connected with menopause leads to modulation of mineral or ionic sensing in the peripheral taste organs. In this study, we analyzed the gene expression in taste buds and taste behavior using the mice with osteoporosis induced by ovariectomy (OVX). First, we conducted RNA sequencing (RNA-seq) to explore gene expression profiles of taste buds in the OVX and sham-operated mice. In the OVX group, the expression of multille genes related to metal ion binding and calcium channel activity were upregulated, compared to the sham-operated group. Next, we examine a short-term (5s) lick test for various taste solutions. The number of licks to $CaCl_2$ and $MgCl_2$ (metallic taste) in the OVX group was significantly lower than in the sham-operated group. These results suggest that the postmenopausal osteoporosis may alter the expression of genes related to metal-binding activity in the peripheral taste organs and enhance the aversive response to divalent metal salts in mice.

P203 Exploration of off-flavor masking materials for soybean odor (hexanal) using olfactory receptor evaluation technology.

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The soybean is widely used in health foods for nutritional enhancement and health maintenance. It is also attracting attention as a lo“-fat and”high-protein food "soy“meat". However, off-flavor ”green flavor (soybean odor)" which mainly consists of hexanal is a problem for plant-based proteins containing products including soybean. One of the conventional off-flavor masking techniques is to cover the off-flavor of concern with a stronger odor component. However, there were problems that such method impairs the original flavor of the food. Therefore, there has been a need for a unique masking technology that does not impair the original flavor of foods. Based on the molecular mechanism of human odorant perception, recent studies have shown that olfactory receptor (OR) antagonists are effective for off-flavor masking. In this study, we used OR evaluation techniques to explore masking compounds for hexanal which is the main component of off-flavor in soybean products. The OR2W1 was identified as an olfactory receptor responsive to hexanal and constructed an antagonist evaluation system. Next, antagonist screening for the OR2W1 was performed on about 1500 compounds and a plurality of compounds with antagonist activities were found. Their masking function was evaluated by sensory evaluation, and some compounds showed masking effect against hexanal odor.

P205 Encoding of retronasal olfaction in the insular cortex

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Odours play a distinctive role in shaping the experience of food consumption, serving as both anticipatory cues and contributors during the consummatory phase, where they combine with taste. The robustness of this association allows odours to enhance taste perception, adopting taste qualities even in the absence of an actual tastant. Despite the established association between odour and taste, the precise mechanism underlying this phenomenon remains elusive. Here, we build on prior research on distributed pattern encoding of tastants in the insula and frontal operculum, along with activations in these structures in response to odours, to investigate the role of odours in flavour processing. Specifically, we combine

behavioural psychophysics and functional neuroimaging to test the hypothesis that odours evoke the same distributed patterns of encoding in the taste cortex. Healthy volunteers (N=28) attended a behavioural familiarisation session with a sweet flavour (a sweet taste with a sweet odour) and a savoury flavour (a savoury taste with a savoury odour). Two subsequent fMRI sessions involved the separate administration of tastants and odourants. Univariate analyses replicated previous findings, showing activation in the insula and piriform cortex in response to tastants and the piriform cortex in response to odours. Multivariate pattern analysis showed robust classification of retronasal odours in the insula. Crucially, while there is evidence of cross-modal encoding, activation patterns in the taste cortex also separated pure odours from pure tastes. These findings underscore the robust chemosensory link arising from lifelong associative learning, with potential implications for promoting healthier and more sustainable diets.

P206 Olfactory organoids with having diverse cell types and responding to odor stimuli

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An organoid is suitable for studying the functional, structural, and biological complexity of that organ. While the generation of olfactory organoids has been conducted, there aren't olfactory organoids with multiple cell types and the olfactory function. By seeding single cells from whole olfactory tissues and culturing with proliferation factors and differentiation factors, we generated olfactory organoids. By immunostaining with olfactory-related markers for the morphology of organoids, differentiated organoids have reversed epithelial polarity (apical-out) that olfactory sensory neurons (OSNs) located at the outer region and progenitors located at the inner region. Furthermore, we specifically confirm that there are not only OSNs but also ciliated cells, microvilli, goblet cells, and basal cells in differentiated organoids by single-cell RNA sequencing. Lastly, we confirm the olfactory function of differentiated organoids by calcium signaling. Finally, we generated olfactory organoids with multiple cell types and the olfactory function.

P207 Studying the interaction of rose essential oil and its constituent compounds with olfactory receptors using calcium imaging and molecular docking

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The aroma of rose essential oil has the advantage of providing physiological and psychological relaxation to humans. In humans, the olfactory system enables the identification and differentiation of various chemical compounds, allowing for the recognition of distinct odors. In this study, we investigated to identify the olfactory receptors that bind to rose essential oil and the binding sites that interact with the major compounds of rose essential oil. We discover 14 types of olfactory receptors that responded to rose essential oil and identified five key aroma compounds in rose essential oil, including 2-phenylethanol, β-citronellol, geraniol, nerol, and geranyl acetate, by gas chromatography-mass spectrometry (GC-MS). Through calcium imaging analysis, 2-phenylethanol, the most abundant compound in rose essential oil, was confirmed to bind to six olfactory receptors in a concentration-dependent manner. Then, we utilized molecular docking to predict the active regions and sites of the olfactory receptor protein modeled by AlphaFold, as well as their interactions with 2-phenylethanol and

rose essential oil. The amino acid residues putative to bind and interact with olfactory receptors were OR1F1(Thr240), OR2AG1(Leu105), OR3A1(Glu55), OR7D2(Ser104), OR11A1(Phe259), and OR13A1(Thr200). These results provide the principles of rose essential scent recognition and regulation through olfactory receptors.

P208 Exercise-induced IL-6 levels are associated with sweet preferences, but not sensitivity, in healthy males

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Taste perception and preference is subject to various influencing factors, leading to inter-individual differences. Many of these determinants have been well studied, but one that has received less attention is habitual physical exercise. While physical activity is often associated with a healthy lifestyle, we hypothesize that habitual physical exercise decreases sweet taste sensitivity due to an inflammation-mediated mechanism, while increasing sweet preferences and intake of sweet foods.

The presented data are secondary outcome measures of a single-blinded, cross-over human intervention study with 32 male volunteers. Sensory evaluations concerning the sweet taste threshold (sensitivity) and intensity, sweet taste preference ratings, anthropometric measures, physical activity, dietary intake, and fasted plasma IL-6 levels were assessed. Data were analyzed using Pearson Product Moment or Spearman Correlation.

A high preference for sweet foods was linked to high intake of sugar (r=0.5135) and fat (r=0.4563), low body fat percentage (r=-0.3274) and increased levels of fasted plasma IL-6 (r=0.327). Body fat was found to be positively associated with perceived sweetness intensity (r=0.3426). However, no correlation was found between sweet taste preference, intensity ratings, and sweet taste sensitivity.

This study shows correlations between indicators of physical activity and sweet preference as well as intensity. Based on the data, an exercise-induced release of IL-6 is hypothesized as an underlying mechanism. This association would be particularly plausible from a physiological perspective, as physically active individuals have higher energy needs, and a reduced perception of sweetness intensity and an increased preference for sweet-tasting formulations would support the fulfillment of these requirements.

P209 Host Plant Preferences of Anopheles Mosquitoes

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Feeding on host plant-derived sugars is essential for mosquito survival and reproduction. Moreover, the nutritional content of plant juices, including, *e.g.,* sugars and secondary metabolites, may have differential effects on infection rates and parasite development duration, and can therefore significantly influence malaria transmission dynamics. Thus, comprehending mosquito-host plant selection is crucial, and may present opportunities for the development of innovative malaria control strategies. In this study, we seek

to identify the natural sugar sources of malaria vectors with the goal of determining the host plant range of non-infected and *Plasmodium*-infected *Anopheles* mosquitoes, using plant DNA barcoding. Mosquitoes were collected using traps baited with synthetic blends of plant and human odor in the malaria-endemic region of western Burkina Faso. The head and thorax of female mosquitoes, identified as *Anopheles spp.,* were individually dissected and separated from the abdomen, then stored at -80°C. To identify recently plant-fed female mosquitoes, the abdomens were homogenized in absolute ethanol, centrifuged and the supernatant tested for fructose content using the cold anthrone test. To determine which plant was fed on, the abdominal pellets were extracted to recover genomic plant DNA, and genetic markers were amplified and sequenced. To determine the *Plasmodium* infection status, the genomic parasite DNA was extracted from the head and thorax followed by marker detection. Our preliminary findings show that *Anopheles* mosquito forage on diverse plant species

P210 Olfactory dysfunction after COVID-19 vaccination

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Background:

Olfactory dysfunction following vaccination is a rare, however noteworthy occurrence. Given the importance of olfaction in daily life and its impact on quality of life, understanding and treating post-vaccination olfactory dysfunction is critical for optimal patient care. We report five cases of olfactory dysfunction following COVID-19 vaccination.

Case:

The reported cases exhibited symptoms within a median of 4 days after vaccination, with manifestations including parosmia and, in two cases, gustatory dysfunction. Despite any other symptoms or negative PCR results for COVID-19, olfactory dysfunction persisted, prompting further evaluation and treatment. Subsequent follow-up assessments revealed varying degrees of improvement, with four patients showing signs of recovery and one patient remaining unchanged, underscoring the complex nature of olfactory dysfunction following vaccination.

Discussion:

The mechanism of olfactory dysfunction after COVID-19 vaccination involves spike protein interactions that trigger inflammatory responses, particularly in the olfactory epithelium. Previous reports documented similar cases related to COVID-19 vaccines. Thorough interviews should be conducted to differentiate potential causes, considering that olfactory dysfunction has multiple factors. Continued research and vigilance are crucial in monitoring and managing olfactory dysfunction after COVID-19 vaccination for better patient outcomes and quality of life.

P211 A multiplexing immunofluorescence study for the detection of the respiratory and olfactory epithelium from human body donors

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The human nose is a fascinating and complex sensory organ that performs a variety of functions, including air filtration, moisture regulation, heat exchange and odor perception. To study the complex tissue organization and cellular composition of the nasal cavity, including the respiratory and olfactory epithelium as well as the olfactory bulb, we have applied the multiplexing method to our human post-mortem nasal specimen. The aim of this project was to stain as many markers as possible and thus to visualize several structures on a human tissue section. For this purpose, different multiplexing approaches already described in the literature were tested, specifically adapted and optimized for our three different tissue samples.

For this approach, first the strong autofluorescence of the respiratory and olfactory tissue was reduced using different concentrations and incubation time of Sudan Black. Next, the antibodies have to been removed from the objectives to perform multiple rounds of staining on the same slide. A significant focus of our work was to ensure that the tissue remained intact and did not detach. With our adjustments we were able to perform a multiplexing assay on the whole nasal specimen focusing on the olfactory epithelium with six different antibodies in four rounds. This method will help to further classifying the olfactory structures and give supplementing knowledge about the complex construction of our nose, the respiratory and olfactory system.

P212 Polycomb Repressive Complex 2 regulates olfactory basal cell fate during adult olfactory neurogenesis

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Adult neurogenesis in the mammalian olfactory epithelium maintains olfactory neurons, the primary sensory neurons for olfaction. Olfactory neurons are prone to external injury, which activates multipotent olfactory basal stem cells, but the mechanisms regulating lineage decisions in these multipotent cells are not understood. We utilized mouse lesion models to identify the role of Polycomb repressive complexes (PRCs) in olfactory epithelial regeneration. PRCs are well-established as chromatin modifiers and transcriptional programmers in developing tissues, and olfactory globose basal cells (GBCs) and nascent neurons express PRC2 proteins. Loss of PRC2 in GBCs perturbs PRC2-deposited histone modifications and disrupts lesion-induced neurogenesis, accompanied by misexpression of lineage-specific transcription factors in GBCs. PRC2-mutant GBCs exhibit de-repression of Bowman's gland-specific transcription factor *Sox9* and increased Bowman's gland progeny, which establishes a novel role for PRC2 in regulating gland versus neuron cell fate. Our findings support a model in which PRC2-dependent mechanisms promote neural cell fate in multipotent basal cells in an adult neurogenic niche.

P213 A new method of collection and classification of odor vocabulary by large scale language processing

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We us” “djecti”e“ such”as "s“lty," ”sweet," "sour," and "bitter" to describe taste qualities on a daily basis, and these adjectives are a taste-specific vocabulary. For expression of odor qualities, however, we do not have such adjectives, but we describe “odor of rubber”, “fragrance of lavender” or “smells like roses”, using nouns with odor qualities.

On the other hand, Japanese smell identification test OSIT-J or OpenEssence were developed based on classification that was made by survey in Japan about twenty years ago, since quality of smells or alternatives using in UPSIT developed in the U.S. were not suitable for Japanese. In the future, for time when this classification of Japanese smells is no longer valid, we attempted to use the aforementioned olfactory vocabulary features, and collected and classified odor vocabulary through a large dataset of product reviews including food and household products.

Specifically, we performed morphological analysis on product review sentences in Japanese that contained odor descriptions, and we compiled the nouns used to describe odors. A total of 617,208 sentences that reviewed odor experiences and their corresponding nouns were collected. The top 100 frequently used odor nouns were classified into 15 clusters according to the context in which they were used.

This method would be useful for collecting evaluations of certain smells (or taste qualities) from the online vocabulary space, rather than directly asking consumers for their impression.

P214 Diversity and regional difference of bitter taste receptor genes in koala

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Koalas, the iconic animal in Australia, depends on eucalypt tree leaves for their diet. Preference of eucalypt species is different among individuals and regions. Although this difference is thought to be adaptation to the local vegetation, what causes it is not understood well. Bitterness is a key to evaluate the presence of toxin in foods and eucalypts contain a variety of toxic secondary metabolites that is potentially recognized as bitterness. Polymorphisms in bitter taste receptor genes (TAS2Rs), which are responsible for the acceptance of bitterness, lead to functional difference of sense of bitter taste. In this study, we hypothesized that TAS2R polymorphisms would cause individual and regional difference of food preference in koalas. We analyzed intra- and interpopulation genetic diversity of 66 TAS2Rs (including fixed and segregating pseudogenes) in 413 koalas. As the hypothesizes is confirmed, there are large differences of diversity and divergence of TAS2Rs. Five TAS2Rs have haplotypes that gained premature stop codons within the coding sequences and two TAS2Rs have haplotypes that lost stop codon, which causes high impact to koalas’ sense of bitter taste. We also analyze whether the large diversity and divergence of koala TAS2Rs is the result of natural selection and/or population dynamics.

P215 Determinants of selective neuronal vulnerability in olfactory bulb dopaminergic neurons

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Dopaminergic neurons in the olfactory bulb are highly activity dependent and are capable of regenerating throughout life. Disrupting sensory input triggers cell death in a subset of OB dopaminergic neurons. We want to determine whether differences in morphology or physiology, which are heterogeneous in olfactory bulb dopaminergic neurons, can predict which neurons are more vulnerable and die and which are resilient to loss of sensory input. We used chronic *in vivo* 2-photon imaging to track the survival and odor response properties of olfactory dopaminergic neurons over multiple weeks. We used both tyrosine hydroxylase (TH)-cre and the dopamine transporter (DAT)-cre mice to drive expression of a red fluorescent marker protein and/or green genetically encoded calcium indicator to track their odor response properties. By systemically injecting the olfactotoxin methimazole (MMZ) we were able to rapidly eliminate all sensory input to the olfactory bulb. We found that cell death is significantly elevated In the first week after MMZ injection aId occurred more prominently in small soma size dopaminergic neurons. We also found that dopaminergic neurons that respond strongly to odors are more prone to cell death than those that weakly, and there was a trend for less odor selective neurons to be vulnerable to cell death. We saw no difference in cell death between TH-cre and DAT-cre reporter mice. This study provides important insight into the mechanisms underlying selective neuronal vulnerability, which in turn may help in developing novel targeted therapeutic strategies to combat various neurodegenerative diseases.

P216 Exploring Olfactory Perception with Language Models

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In this research, we delve into the capabilities of language models (LMs) to embody sensory information, with a special focus on olfaction. This sensory modality is notably underrepresented in language, presenting a distinct challenge for natural language processing methods. Through an extensive examination involving four–different generations of LMs - Word2Vec– fastText, BERT, and ChatGPT - and testing them across almost 200 training scenarios, we aimed to assess their ability to grasp and represent human odor perceptions based on textual data alone.

The study utilized three distinct sets of odor-related data, encompassing the novel perceptual and imaginary ratings of odor similarities, as well as the established Dravnieks data. This comprehensive approach al’owed us to analyze the models' effectiveness in capturing the different aspects of olfactory perception through language.

Our analysis uncovered that the static models, Word2Vec and fastText, demonstrated notable proficiency in reflecting perceptual similarities between odors, particularly when configured under specific training conditions. On the other hand, more advanced contextual models like ChatGPT showed a better ability to model olfactory-semantic associations, outperforming in scenarios where the similarities between odors were inferred from conceptual or linguistic cues rather than direct olfactory input.

The outcomes of this investigation shed light on the potential of LMs to accurately mirror human sensory experiences, through olfactory perception, in language. By revealing the strengths and limitations of different LM generations in processing sensory information, this study sets a foundation for future exploration into language processing and the advancement of sensory-aware AI models.

P217 Molecular Mechanisms underlying the Establishment of Olfactory Epithelium Spatial Patterning

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Odor information processing commences with its detection in the olfactory epithelium. In mice, this epithelium is segregated into two distinct zones, dorsomedial zone (D-zone, also known as zone 1) and ventrolateral zone (V-zone, also known as zone 2-4), characterized by their molecular profiles. The D-zone has been implicated in the regulation of innate aversive behavior, whereas the V-zone modulates learning-dependent behavior. Thus, the zonal architecture serves as the structural basis for the circuitry involved in olfactory information processing. Nevertheless, the mechanism underlying the earliest specification of zone structure has yet to be elucidated.

Previous studies have demonstrated that the transcription factor Foxg1 is selectively expressed in the V-zone of the olfactory epithelium, raising the possibility that Foxg1 plays instructive roles in establishing zone-specific olfactory epithelium patterning. To assess this, we focused on the early roles of Foxg1 using genetic loss-of-function mutation. Analysis of *Foxg1* mutant mice revealed mis-segregation of zones despite maintained neuronal differentiation, accompanied by altered Foxg1 promoter activity, indicating the presence of an upstream regulator of zone formation. We further performed expression and inhibitor analysis to screen for candidate molecules involved in the early patterning of zone structure in the ”evel’ping olfactory epithelium. Our results revealed the cooperative roles of morphogen and transcriptional network in establishing the earliest dorsomedial and ventrolateral zone territory, which is a critical step in understanding the molecular mechanisms underlying innate and learned olfactory information processing.

P218 The sweet taste mechanism of the plant aroma compound

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Numerous chemical compounds contribute to taste and aroma, usually classified as hydrophilic molecules for taste and volatile hydrophobic molecules for aroma. However, some plant-derived aroma compounds exhibit sweet taste, and it is not clear how they bind to sweet taste receptor, T1r2/T1r3. Therefore, we conducted a study to identify sweet-tasting compounds among plant-derived aroma compounds and to investigate the mechanisms of the aroma compounds binding to T1r2/T1r3. First, we screened for novel sweet compounds using HEK293 cells expressing human T1r2/T1r3 and calcium imaging technique, and identified one plant-derived aroma compound that activates human T1r2/T1r3. We then elucidated how this novel sweet aroma compound, together with known sweet aroma compounds, binds to the sweet taste receptor T1r2/T1r3. Interestingly, we found that these compounds activate human T1r2/T1r3 while inhibiting the activity of mouse T1r2/T1r3 by sweetness. Furthermore, when the binding regions were examined using human and mouse T1r2/T1r3 chimeric receptors, it was

found that these compounds bind primarily to the transmembrane domain of T1r2, unlike many hydrophilic sweetening compounds that bind to the ligand-binding domain of T1r2. These experimental results not only suggest the existence of a new binding mechanism for T1r2/T1r3, but also suggest new applications for aroma compounds that affect food preferences, including both taste and smell.

P219 Taste perception of salt substitute in the brain: preliminary EEG findings

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The increasing prevalence of hypertension and cardiovascular diseases has prompted a search for dietary strategies that can reduce sodium intake without compromising taste. Potassium chloride (KCl) is widely used as a salt substitute, despite its bitter aftertaste. This study investigated how the brain perceives these substitutes compared to salt. Throughout the sensory evaluation of saltiness (n=49), a low concentration of 0.1 M NaCl was found to be equivalent to a mixture of 0.07 M NaCl and 0.06 M KCl, and a high concentration of 0.3 M NaCl was equivalent to a mixture of 0.21 M NaCl with 0.11 M KCl. We analyzed brain activity and connectivity (n=10) exposed to these four salt solutions using a 256-channel EEG system. At lower concentrations, salty and bitter tastes did not differ significantly between the NaCl and NaCl + KCl mixtures. At higher concentrations, the NaCl + KCl mixture had a significantly higher bitter taste without affecting saltiness. Brain activity, measured by insula and OFC spectral power, showed no significant differences at any concentration. However, higher concentration increased insula-OFC connectivity in the mixture, suggesting a heightened neural processing of the complex taste profile. This enhanced connectivity, involving the OFC-key regions for reward and aversion-indicates a refined integration of sensory informatio' that could reflect the brain's evaluation of the increased bitterness as an aversive stimulus. Our findings underscore the importance of considering the neural basis of taste perception in developing dietary strategies aimed at reducing sodium intake without diminishing taste satisfaction.

P220 Electrophysiological features across neuronal types in the primary olfactory center of the insect brain

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The noctuid moth, *Helicoverpa armigera*, relies heavily on its sense of smell for feeding, mate-finding, and oviposition behaviors. The primary olfactory center, called the antennal lobe, contains numerous neuronal types and sub-types partaking in the facilitation of these behaviors. Understanding the morphological and electrophysiological features of these neurons is of particular interest, especially with respect to the various types of projection neurons and local interneurons. The projection neurons send signals to higher-order regions associated with memory formation, valence assessment, and innate behaviors, while the local interneurons modulate and sharpen information processing in the antennal lobe and thereby indirectly affect downstream processing.

Here, we present unpublished findings related to the electrophysiological features of projection neurons which send information via five distinct pathways to protocerebral output regions, as well as the antennal lobe local interneurons. We performed *in vivo* sharp intracellular recording and labelling, while stimulating

the moth with various pheromones and plant-associated odorants. Our analyses include across-category comparisons of stimulus-response features as well as parameters relating to spontaneous activity patterns and biophysical properties of various projection neurons and local interneurons.

P221 The palate palette: unraveling the effect of savoury taste phenotypes on food acceptance, consumption and nutritional status by gender

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The present study explored the effect of taste responsiveness on eating habits and nutritional status by gender. Two-thousand-eight-hundred-seventy-eight volunteers (54.5% F; age: 18–60y) rated liking and perceived intensity of 3 sensations (salty, umami and overall flavor) for a model food spiked with 4 increasing levels of NaCl. Individuals self-reported anthropometric information and consumption data for a series of food. K-means clustering performed by gender on Pearson's coefficients between liking and responsiveness to the target sensations revealed, for women, 'Savoury-taste-Likers' (n=698) and 'Savoury-taste-Dislikers' (n=872) phenotypes for which liking, respectively, increased or decreased along with NaCl concentration. For men, 'Savoury-taste-Dislikers' (n=838) and 'Savoury-taste-Lovers' phenotypes (n=470) were found, the latter showing the highest liking scores for the saltiest foods. In women, the 'Likers' phenotype was characterized by a lower sensitivity to salty, umami and overall flavour than the 'Dislikers' phenotype, while in men this association was less pronounced. Both 'Likers' and 'Lovers' phenotypes (irrespective of gender) displayed a higher consumption frequency of caloric meals or junk foods, red and cured meat and both saturated and unsaturated fats, yet only the 'Savoury-taste-Lovers' phenotype was associated with increased BMI. These data highlight the importance of taste as explanatory variable in the development of unhealthy eating patterns and stress the need of considering gender-related differences for the implementation of personalized dietary interventions.

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P222 Sweet off-response in type III taste cells

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Type III cells in the taste buds are known for encoding sour taste, as well as other chemical modalities such as carbonation, saltiness, water taste, and etc. Here we report a novel functional role of type III cells in encoding of sweet off-response. Using in vivo functional imaging of genetically-targeted type III cells in fungiform taste buds, we observed that a subpopulation of sour-sensing type III cells exhibits calcium activity in response to sweet offset, but not the onset, amidst the termination of prolonged sweet stimuli. Pharmacological inhibition experiments suggested that sweeteners may hyperpolarize type III cells. Following washout of the sweetener may cause rebound potential via t type voltage gated calcium

channels. Analogous to the off-response in auditory neurons and thalamic neurons, this mechanism might account for the sweet off-response. Taken together, these results may indicate that various aspect of taste perception may be relayed by type III cells.

P223 Unique neural population seletively expressing 3 odorant receptors during development of olfactory system and its link between GnRH neuronal migration

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During early development, the olfactory placode (OP) generates a variety of cell types such as olfactory sensory neurons(OSN) and gonadotropin-releasing hormone(GnRH)-producing neurons. The GnRH neurons emerge in the OP area but they migrate into the hypothalamus during E11-E14. Kallmann syndrome, which is induced by disrupted migration of GnRH neurons, is characterized by impaired olfactory function and infertility, suggesting the existence of a link between the olfactory system and GnRH development. However, the precise interplay between the olfactory system and GnRH neuron migration is still enigmatic. Here we leverage single nucleus RNA-seq data which covers whole embryonic stages to resolve the cell type and molecular diversity during olfactory placode development. We identified an undiscovered population of olfactory sensory neurons characterized by their selective expression of specific odorant receptors (Olfr15, Olfr31, Olfr571) during E11-14, which is the same timepoint of GnRH neuron migration. Unlike other OSNs, these neurons express voltage-gated potassium channels and Prokinectin 2 receptor which is associated with GnRH neuron regulation. Remarkably, their DEGs align with ge'es known as Kallmann syndrome's risk gene and axon guidance-related genes. Our findings open a compelling avenue for further exploration, offering potential insight into the complex interplay between the olfactory system and reproductive neuroendocrinology.

P224 Correlative intravital and histological imaging on intact taste buds

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Understanding the physiology of taste cells requires multifaceted cellular information from gene regulation to functional responses. A variety of experimental approaches for obtaining each biological information is available, such as in situ hybridization for gene transcription and microfluidics-integrated intravital microscopy (μTongue) for functional responses. However, the acquisition of genetic and functional information correlatively at a single-cell level has yet to be realized for taste cells, hampering a comprehensive understanding of the causal interaction between gene and function. Here, we report a novel data acquisition pipeline providing correlated information on tastant-evoked functional responses of taste cells *in vivo* and their transcriptional regulation. In this pipeline, *in vivo* functional data is firstly acquired from several taste buds using μTongue and then the vicinities of the taste buds of interest are marked by using near-infrared branding. Using the branding as a landmark, the same taste buds are re-identified in a sliced tissue and processed for in situ hybridization. As a proof-of-principle, we performed *in vivo* imaging of sour-responsive cells in fungiform taste buds, and correlatively performed in situ

hybridization targeting OTOP1, resulting in single-cell-level correspondence. Our proposed pipeline is broadly compatible with recent spatial transcriptomics and proteomics approaches for generating large-scale correlative datasets.

P225 Succinate triggers long-range Ca2+ waves via TRPM5-expressing tuft cells across the tracheal epithelium

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Less than 1% of the tracheal epithelium is composed of tuft cells (previously brush cells), which are chemosensory cells expressing the transient receptor potential channel TRPM5. Their activation stimulates mucociliary clearance through the paracrine release of acetylcholine (ACh). It is unclear how the punctate release of ACh from a rare epithelial cell type leads to epithelium-wide effects. To examine tuft cell-induced epithelial-wide activity, we first sought a relevant receptor-ligand pair specific for tuft cells. The succinate receptor SUCNR1 is exclusively expressed on a subset of tracheal tuft cells. To visualize the potential spread of activity with high spatial and temporal resolution in the intact epithelium, we have developed a Ca^{2+} imaging technique that allows us to record intracellular Ca^{2+} activity in virtually every cell of the tracheal epithelium while identifying individual tuft cells. Succinate-stimulated tuft cells trigger long-range Ca^{2+} waves spreading radially over the tracheal epithelium through a sequential process. First, tuft cells release ACh, which activates nearby cells via muscarinic ACh receptors. From there, the Ca^{2+} wave propagates through gap junction signaling, reaching distant ciliated and secretory cells boosting mucociliary clearance and chloride secretion. Our data establish that tracheal tuft cells play a central role in triggering succinate-evoked Ca^{2+} waves which initiate a global epithelial defense program.

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P226 Does an odor elicit visual recognition memory in the infant brain?

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It is assumed that odors can elicit memories in human adults, but whether odor-evoked memory operates in infancy remains largely unknown. Here, we measured visual recognition memory in 4- to 6-month-old infants using scalp electroencephalography (EEG), and estimated the effect of an odor associated with the visual stimuli during learning and recognition. Twenty-four infants were tested twice (minimum 1-week interval between appointments) while they were exposed to rapid streams of visual stimuli (36 stimuli = 3 sets × 12 categories). For each infant, one stimulus set was learned between the two appointments using a book that parents had to show and read each night. During the experiment, this set was presented at 1 Hz within the stimulation stream to tag a visual recognition response at the same frequency in the EEG spectrum. At both appointments, two odors were alternatively presented during visual stimulation, one of them being associated with the learned stimuli (the book was odorized). Results revealed no significant response at 1 Hz at the first appointment (before learning), whereas a significant visual recognition response to the learned images was identified at the second appointment (after learning) over left occipito-temporal brain regions. However, at both appointments, there was no difference between the two odor conditions, as confirmed by Bayesian analysis. Therefore, while we were able to measure visual recognition memory in the infant brain using EEG, we did not find evidence that an odor associated with the learned visual stimuli enhances their subsequent recognition.

P227 In vivo testing of genetically encoded voltage indicators in the mouse olfactory system

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Genetically encoded voltage indicators (GEVIs) are fluorescence protein-based optical indicators that report changes in membrane potential via fluorescence changes. The GEVI ArcLight has been useful for studying the neural responses from different cell types within the mouse olfactory bulb. However, numerous groups have reported newer and more sensitive GEVIs that can report neuronal activity in vivo. To test whether these new sensors facilitated imaging from the mouse olfactory bulb in vivo, we screened the ability of ArcLight, and four other GEVIs developed in the last 3 years (ASAP3, ASAP4, Ulla and Ulla16) on the ability to detect odor-evoked activity in vivo using 1-photon and 2-photon microscopy. GEVI expression was targeted using different adeno-associated viral vectors in a constitutive or cre-dependent manner. Most of the tested GEVIs were able to detect odor-evoked activity in the mouse olfactory bulb both under epifluorescence fluorescence and 2-photon imaging, although there were a range of different signal-to-noise ratios and ability to clearly report respiratory coupled dynamics. This systematic testing of different GEVIs in the same preparation and experimental apparatuses may be useful for assessing the relative merits of any individual GEVI, and will facilitate their uptake in studying the mammalian olfactory system.

P228 Deprivation of visual stimuli increases sensitivity to sweet taste in a Vietnamese population.

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In our previous study, temporary visual deprivation increased sensitivity to sweet but not other basic tastes in a Central European population. Our goal was to investigate whether this is a more general trait

independent of ethnicity/geographic region. Therefore, we assessed taste recognition thresholds for basic tastes: sweet, bitter, salty, sour and umami in a Southeast Asian population, the Vietnamese.

The thresholds were measured with a standard method (ISO 3972:2011. Sensory analysis) in two conditions: when participants (N=50, both sexes) had their eyes open, and when blindfolded. We defined basic tastes using sucrose (sweet), crystalline caffeine (bitter), citric acid (sour), sodium chloride (salty), and monosodium glutamate (umami). These substances were dissolved in distilled water, at six different concentrations each. Recognition thresholds were assessed with the sip-and-spit method.

Participants recognized sweet taste at a lower recognition threshold (lower sucrose concentration) when they were blindfolded than when their eyes were open (2.76 g/l and 3.80 g/l of sucrose, respectively, p = 0.024). Recognition thresholds for bitter, salty, sour and umami did not differ between the two experimental conditions. These results are consistent with those obtained previously in the Central European population, which suggests that t–e sensitivity of sweet taste - and only sweet taste out of th– five basic taste modalities - to temporal visual deprivation could be a general trait independent of ethnicity/geographic region. Our results suggest that a visual component could have a different share of the coding of different taste modalities in taste-responsive brain regions.

P229 Patients with Parosmia respond faster to unpleasant odors than patients with hyposmia: insights from olfactory event-related potentials

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Introduction: Diagnosing parosmia is a challenge. The present study aimed to explore the distinctions between hyposmic patients with and without parosmia utilizing EEG-derived olfactory event-related potentials (ERP).

Methods: Forty-four patients with hyposmia were enrolled and divided into a group with parosmia (n=23, mean age±SD=48±14 years, 7 men) and one without parosmia (n=21, age=52±12, 7 men). Diagnosis of parosmia was based on the clinical interview. Additionally, 21 healthy controls (mean age=45±14 years; 6 men) were included. Various measurements were obtained, including the Sniffin' Stick test, threshold tests for the odorants furfural mercaptan and 2,6-nonadienal, a modified Sniffin' Stick parosmia test, and well-being ratings. Chemosensory ERP were recorded separately for each nostril using high-precision, computer-controlled air-dilution olfactometry.

Results: Patients with parosmia had a decreased olfactory function similar to that observed in patients with hyposmia, although the odor sensitivity of patients with severe parosmia appeared relatively unaffected. Patients with parosmia reported a decrease in well-being compared to controls. The severity of parosmia was positively correlated with odor sensitivity. Furthermore, patients with severe parosmia exhibited faster chemosensory ERP responses to unpleasant odors compared to patients without parosmia.

Conclusion: Overall, the present findings support the idea that parosmia predominantly occurs during olfactory recovery, significantly disturbing patients and warranting the development of effective treatments. Notably, the relatively faster ERP responses of hyposmic patients with parosmia suggest that the generation of distorted olfactory responses may involve already early stages of the processing of olfactory information.

P230 Behavioral and molecular responses to sweet stimuli vary in songbirds

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Although the ancestor of modern birds is thought to have lost its ability to detect sugars in its diet, early songbirds have re-gained sugar sensing through repurposing their savory taste receptor. This ancestral sensory trait may have enabled non-nectar-feeding songbirds to consume nectar and fruit as fuel during migration. Intriguingly, while most songbirds combine sweet sensing with the physiological ability to digest carbohydrates, members of the Muscicapida clade (including starlings and their relatives) are incapable of digesting sucrose. Whether species of this sucrase-deficient clade can also detect dietary sugars is currently unclear. Here, we investigated the carbohydrate preferences of starlings and their relatives using brief-access two-choice tests in captivity and in the wild during migration. We observed that, in accordance with their sucrose intolerance, starlings and some other Muscicapida members do not display any preference for sugars. In contrast, songbirds in the Sylviodea superfamily (i.e. blackcaps), which are predicted to have intact sucrase activity, display immediate and significant preferences to sucrose as well as hexoses. These results, together with current experiments on the molecular basis of taste receptor sensitivity and sucrase activity, will shed light into how sensory abilities may shift in relation to physiological changes during vertebrate evolution.

P231 The adaptations underlying olfaction in mice with OB degeneration

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Blood vessel maturation during brain development is spatially and temporally organized. Based on the fact that OB vessels are among the last to mature, we developed a mouse strain capable of causing immature OB vessels regression during development. These mice are viable and fertile adults despite the fact that they have as little as 3% of normal OB volume. Histological examination shows highly aberrant circuitry: loss of typical segregation of olfactory sensory neuron (OSN) axons, a markedly reduced number of mitral/tufted cells and loss of their apical dendrite compartmentalization.

Mice were tested in several innate and learned olfactory behavioral tests and showed surprisingly potent olfactory skills. Moreover, normal odor-evoked responses were recorded from piriform cortex. We employed histological and bioinformatic tools to analyze the mechanisms underlying olfaction. We found a nearly-full repertoire of receptors in OSNs. OSN axon was often found in ectopic regions such as the granule and mitral cell layers in the OB, in the AON, RMS and even in piriform cortex. Strangely, some cells in piriform cortex express Tbet, which is a mitral cell marker. In some cases, the dendrites of these peculiar cells were in contact with the ectopic axons of OSNs.

Spatial transcriptomics of the OB revealed that the glomerular layer of the degenerated OB, specifically, is highly enriched with inflammatory markers.

Since humans with reduced OB volume and intact olfaction have been reported, the above data may imply to processes happening in humans and also may suggest a vascular-based mechanism for their OB degeneration.

P232 The capacity limits of olfactory working memory

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Working memory (WM), a fundamental cognitive function, involves an 'online' maintenance of information, and the amount of information that can be temporarily maintained is limited. While research explores working memory (WM) capacity across various sensory modalities, including olfaction, no studies have specifically examined its capacity constraints in humans. In two experiments, we aimed to test the limits of working memory capacity for storing olfactory information and for how long before the memory traces of an o"or f'de wiIh time. The first experiment investigated whether a single odor can be retained in WM ove" dif'Irent delay periods. On each trial, an odorant (item) is presented followed by another odorant (probe) after one of three delays (6s, 12s, 24s). We found that recognition performance, although it decreases with increased delays, is still well above chance level, thereby signifying the capability of our human mind to temporarily maintain a representation of an odor in short-term memory. Most importantly, we used difficult-to-name and unfamiliar odorants as stimuli to hinder the process of labelling. The second study employed Sternberg's paradigm to assess the capacity of olfactory WM. Participants were tasked with detecting whether a probe matched any item in a set ranging from 1 to 5 items. Initial observations suggest that olfactory WM exhibits capacity limits similar to those observed in other sensory modalities. These early insights contribute to our understanding of olfactory cognition and thereby underscore the importance of further investigation into the mechanisms underlying olfactory WM.

P233 Elucidating the role of odor mixture temporal structure in human olfactory perception

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Odors are said to be represented in the brain via a "spatiotemporal" code. However, while the relevance of a spatial neural code in conveying odor identity is well established, the role of temporal information is comparatively poorly understood. To improve this understanding, we are using psychophysical and functional magnetic resonance imaging (fMRI) methods to probe the impact of temporal manipulations of odor mixture subcomponents on human olfactory perception, discrimination, and neural representations.

Presently, participants (n=13) completed a signal detection-based odor discrimination task in which they were tasked with repeatedly discriminating a control sample—a binary odor mixture in which components are presented simultaneously—from five alternative samples composed of identical subcomponents but in which the onset of one odorant is delayed by a range of temporal intervals (79, 243, 427, 676 or 957 ms). This task was completed during MRI scanning, allowing simultaneous collection of both discrimination responses and functional blood-oxygenation-level-dependent (BOLD) MRI images.

This work reveals that minor alterations to odor mixture temporal structure enable significant discrimination between mixtures composed of the same odorant building blocks. While discrimination performance at the slightest temporal stagger (79 ms) did not significantly exceed chance (0.53 ± se 0.03, p=0.245), stimuli composed of greater temporal staggers were discriminated at rates significantly–greater than chance (0–58±0.03 - 0.73±0.04, p's=0.034 - 4.3 x 10^{-12}). Forthcoming analyses will leverage

simultaneously collected MRI data to index neural representation similarity corresponding to these temporal stimuli manipulations in key olfactory cortices including the piriform, orbitofrontal cortex, and amygdala.

P234 Innate Immune Function of the Sustentacular Cells in the Olfactory Epithelium

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The olfactory neuroepithelium (OE), located within the nasal cavity, is constantly in contact with various pathogens due to its direct exposure to the external environment. Sustentacular (Sus) cells, which span the surface of the OE, are traditionally known to provide structural support to olfactory sensory neurons. However, their innate immune barrier functions have not yet been characterized. We established a novel primary Sus cell culture protocol by isolating Sus cells from Cyp2g1 reporter mice and subsequently expanding the cell population *in vitro*. Cultured cells were shown to express Sus cell-specific markers, Cyp2g1, Cyp2a5, and Pax6. To assess the innate immune capacities of Sus cells, we first exposed them to Poly(I:C), a synthetic viral analog. Upregulation of interferon-stimulated genes such as *Isg15*and *Ifit3*was observed at 16 hours post-exposure. When Sus cells were exposed to SARS-CoV-2 (CoV2), upregulation of interferon-stimulated genes was also detected at 72hr post-infection. We observed that while cultured Sus cells were susceptible to CoV2 entry, they did not support the production of infectious viral particles. To further examine the antiviral response of Sus cells *in vivo*, we infected K18-hACE2 transgenic mice with CoV2 and performed single-cell RNA sequencing, immunohistochemistry, and RNAscope in situ hybridization. CoV2 infection triggers restricted Type I & III interferon expression in those infected Sus cells. Consistent with in vitrofindings, interferon-stimulated responses were observed within the Sus cell population, indicating their capacity to mount an innate immune defense that is protective of the OE.

P235 The Shaping of the Self Through Olfactory Preferences

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Olfaction is an affective sense: we perceive smells as being pleasant or unpleasant. This embodied evaluation is dependent on biological, social, and biographical factors. Given the hedonic value that the odours have for the subject, the perception of smells can be framed as a species of affective intentionality. In this talk on the philosophy of perception, I argue that the shaping of olfactory tastes plays an important role in the formation of the embodied affective self. This theme will be here explored through th” too’s coming from phenomenology, philosophy of mind and the history of the senses, and thI upshot w”ll b’ that coherence in the evaluation of the odours enables a sense of cohesion of the self. What would i” fee’ like, to perceive usually familiar odours as being suddenly repulsive? The formation of olfactory t”stes’enables the subjects to navigate the environment with the ability to smoothly discern familiar from unfamiliar olfactory scenarios, to distinguish things that matter from things that don’t to them – even if the perception of odours often remains under the threshold of consciousness. And since olfactory tastes depend on sociocultural norms and subjective memories, the ability to olfactory evaluate the environment and orient oneself in it is strongly dependent on the history of the subject. When we breathe, we take a stance towards the world – a positioning that is dependent on our values and experiences.

P236 Cooperative dynamics between the olfactory sensory neurons and supporting cells in the olfactory epithelium through the aquaporin-4 water channel

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Aquaporin-4 (AQP4) is a water-selective channel expressed in glial cells throughout the nervous system, serving as the main water channel in the neuropil. AQP4 is involved in physiological functions, ranging from water homeostasis by adjusting cell volume to neuronal activity modulation. AQP4 has different isoforms with various expression patterns and functions, including AQP4M23 and AQP4ex, that are expressed in the sustentacular cells (SUSs) of the olfactory epithelium (OE). Mice lacking all AQP4 isoforms exhibit impaired olfactory abilities, prompting investigation of their role in OE. First, we explored AQP4's role in modulating odorant-evoked responses through electro-olfactogram recordings in mice lacking either AQP4M23 or AQP4ex. Both the models exhibited reduced odoIant responIes, indicating their involvement in odorant detection. EOG record the summated generator potential from all olfactory sensory neurons (OSNs) responding to the odorant stimulus. Thus, a reduced response could be due to an altered signal transduction cascade or fewer responsive OSNs. Indeed, cell count revealed an overall reduction in mature OSNs, SUSs and globose basal cells (GBCs), indicating AQP4 isoforms are involved in maintaining an optimal microenvironment in OE, preserving cell density. These data correlate with deficits in odor-guided food-finding in AQP4ex-KO and AQP4M23-KO mice. Furthermore, AQP4ex-KO mice exhibited reduced ability to discriminate between odorants, while AQP4M23-KO mice could not recognize differences, implying distinct functions of the two isoforms. Overall, our findings highlight the crucial role of SUSs and AQP4 molecular machinery in ensuring optimal odorant detection.

P237 Deciphering the signalling cascade activated by olfactory alerting molecules in the mouse Grueneberg ganglion neurons

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In the wild, mice have developed abilities to sense volatile cues that warn them from potential danger. The mouse olfactory system is crucial for danger detection with a critical role for the Grueneberg ganglion (GG) subsystem. Olfactory GG neurons can detect both intra- and interspecific danger cues. As the precise signalling pathway occurring in GG neurons is still unclear, we have developed an *in vitro* assay, using HEK cells, allowing to investigate the different putative cascade elements expressed separately or together. For example, we expressed, in this heterologous model, the three known bitter taste receptors (TAS2R115, TAS2R131 and TAS2R143) present in GG neurons, the cyclic nucleotide-gated channel type A3 (CNGA3), essential for the entry of Ca^{2+} inducing the depolarization of the membrane and the particulate guanylyl cyclase subtype G (pGC-G) identified as an alarm pheromone detector. We verified systematically the expression of these elements by immunocytochemistry and confirmed that they are expressed at the cell membrane. We performed calcium imaging experiments where we first perfused biological secretions from predators and observed that we can mimic, in our *in vitro* system, GG neuronal responses. We then exposed the stimulated cells to a series of pharmacological activators and/or inhibitors to determine the implication of the transfected GG cascade elements. Our findings are a first

step towards the understanding of intra- and interspecies danger communication that takes place in the Grueneberg ganglion neurons.

P238 iRhom2 regulates olfactory receptor landscape

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Olfaction, the sense of smell, relies on the unique ability of olfactory sensory neurons to continuously regenerate and adapt to the environment. Olfactory detection hinges on activation of various combinations of different olfactory receptor types to discern diverse odors. Interestingly, not all receptors are equally represented within the olfactory receptor landscape, depicting the varying ratios or abundance of individual olfactory receptors. The mechanisms underlying these variations, influenced by different genetic and environmental factors, remain poorly understood. To explore how the olfactory receptor landscape is regulated, we investigated the iRhom2/Adam17 pathway in the olfactory epithelium. iRhom2"is a'IositIve regulator of Adam17 which is an important cell surface metalloprotease known for its involvement in regulating cell survivability. We observed that iRhom2 is expressed in a specific subset of mature olfactory sensory neurons. Furthermore, bulk RNAseq on iRhom2 knockout mice reveals that iRhom2 regulates the olfactory receptor landscape, offering a novel perspective on the dynamics of receptor expression in the olfactory system. Additionally, by leveraging publicly available single cell RNAseq datasets we observed that iRhom2 expression is influenced by both odor stimulation and environmental factors. We hypothesize that iRhom2 is important for regulating the olfactory receptor landscape by modulating the odor-dependent survivability of the olfactory sensory neurons.

P239 Co-expression diversifies the Olfactory Receptor repertoire in the maxillary palp of Drosophilids.

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The olfactory environment changes quickly based on the presence/absence of plant and animal species. To keep up with those environmental dynamics, between and intra-species variability of olfactory receptor (OR) expression is one of the ways evolution performs quick shifts in organisms reliant on olfaction, like flies. In adult flies, one of the main olfactory organs is the Maxillary palp (MP), with unique signatures that allow long-range detection of yeast and fruit volatiles. However, the transcriptomic evolution of the MP-OR repertoire has yet to be described. Here, we used an RNA-seq and HCR approach to evaluate gene expression changes through the evolution of *Drosophilids*. In long evolutionary times, the duplicative nature of OR genes enables a birth-death process that could eliminate genes from the genome or a lack of expression in well characterised MP-ORs. Most OR expression gains are lineage-specific, but some show multiple convergences and an ongoing evolutionary process where in the same species two alleles have opposite effects; one allows high expression whereas the other represses it. The fate of the different OR gains -whether in short or long evolutionary times-, is co-expression in a previously known Olfactory Sensory Neuron. Additionally, a re-analysis of publicly available *D. melanogaster* scRNA-seq shows many co-expression pairs, suggesting that at the mRNA level, the co-expression of ORs is not that rare.

These results challenge the idea of one OR per each olfactory neuron, and that the Maxillary palp is evolutionarily very conserved.

P240 Probing the complexity of salt taste signaling and the relation between ENaC regulators and ACE2 in cultured human fungiform (HBO) taste cells

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There is considerable evidence that epithelial Na^+ channels (ENaCs) play a role in human salt taste sensing in mammals. ENaC is composed of four subunits (α, β, γ, and δ) which are expressed in a subset of HBO cells. Salt taste has two distinct signal transduction mechanisms that involves amiloride-sensitive and amiloride-insensitive salt taste responses. Aldosterone regulates ENaC expression and intracellular trafficking of ENaC subunits in cultured human fungiform (HBO) taste cells. However, detailed studies involving the underlying salt taste transduction mechanisms, and their regulation by hormones, associated receptors, and intracellular signaling intermediates are lacking in human taste cells. In this study, we demonstrated that the G-protein-coupled estrogen receptor (GPER1), the transient receptor potential cation channel subfamily V member 1 (TRPV1), and components of the renin-angiotensin-aldosterone system (RAAS) are expressed in δ-ENaC positive in HBO taste cells. In addition, we have provided evidence of expression of angiotensin-converting enzyme 2 (ACE2) receptor, the receptor for COVID-19 in HBO cells. Our results suggest that in human salt-sensing taste cells, some of the ENaC regulators are most likely present in a complex and that changes in the expression of one or more regulators can alter the expression of other effectors. Supported by VCU CCTR and VETAR grants to VL and SM.

P241 Intranasal delivery of AAV vectors in the olfactory system of Peromyscus deer mice

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Adeno-associated viruses (AAVs) are commonly used for *in vivo* gene transfer and medical therapy. A number of AAVs-administration techniques without the need of specialized surgical manipulation and equipment have been proposed to improve the rate of infectivity with undetected toxicity in various organs and cells. Olfactory perception – the ability to smell – is an essential sensory modality of animals and plays a crucial role in mediating appropriate behaviors. Rodents possess two main subsystems for the detection of olfactory information, namely the main olfactory epithelium (MOE) and the vomeronasal organ (VNO). AAVs infection of the olfactory epithelium and its sensory neurons (OSNs) has been used to study odorant receptor function, signal transduction and could provide an alternative for the genetic modification of behavior. Nevertheless, the rate of AAV infection can be inconsistent between target organs and across species. Here, using *Peromyscus* deer mice which are emerging as an alternative model species to study behavioral evolution, we explore the efficiency and efficacy of intranasal delivery of different AAVs serotypes in the olfactory system of adult deer mice. We found that the intranasal delivery of AAVs showed efficient but variable infections in the specific OSNs of MOE and VNO, with a higher infection rate in MOE than in VNO. Moreover, the infection rates differed across the tested AAV

serotypes. This work will contribute to the application of genetic modification via the intranasal delivery of AAVs in the olfactory systems of non-traditional model animals.

P242 Gustatory nerve fiber innervation drives presynaptic specialization accumulation in taste receptor cells.

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Mammalian taste buds are highly regenerative, and are able to restore themselves following physical and chemical insults including burns, chemotherapy, and nerve injury. This is due to the continual proliferation, differentiation, and maturation of taste progenitor cells which then must reconnect with peripheral gustatory neurons to relay taste signals to the brain. The turnover and re-establishment of peripheral taste synapses is vital to maintain this complex sensory system. Despite the importance of neuron-taste cell reconnection, how synapses are assembled and how the specificity of synaptic connections is achieved is largely unknown. Here, we employed the use of presynaptic markers, bassoon and calhm1, to probe whether nerve fiber connectivity is an initiating factor for the recruitment of presynaptic machinery. We performed immunohistochemistry to identify whether presynaptic specializations in type II and type III cells were occupied by nerve fibers, and whether or not the presynaptic specializations persisted following nerve transection. We found that the large majority of presynaptic specializations are directly adjacent to nerve fibers, leaving about 5% unoccupied by gustatory neurons. In the days immediately following nerve transection and complete nerve die-off, we found that presynaptic specializations were almost entirely abolished. Given these data, we conclude that presynaptic specializations are only present when nerve fibers are connected to the taste receptor cell, therefore, the innervation of nerve fibers are indeed necessary for the recruitment of presynaptic specializations. These findings aid in understanding the mechanisms driving synaptogenesis within the rapidly changing taste bud environment.

P243 Deciphering the Spatial Alphabet of Olfactory Perception: Insights from Neural Activity Patterns in Rodents

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In the intricate landscape of olfactory perception, odorants interact with receptors on olfactory sensory neurons within the nasal cavity, initiating a cascade of neural activity. This activity is then transformed into spatial patterns within the olfactory bulb, representing a complex code that underlies our perception of smells. While previous studies have illuminated the relationship between these patterns and odorant chemistry, deciphering the precise mechanisms by which perceptions emerge has remained elusive.

Leveraging advanced techniques including non-negative matrix factorization, we analyzed a publicly available dataset of 143 single odorant 2DG-uptake images of bulbar activity in rodents. Remarkably, our analysis revealed a concise coding alphabet comprising only 9 distinct spatial modules. These modules efficiently decompose the experimental data, shedding light on the fundamental organization of olfactory perception.

Our findings offer compelling insights also into the hierarchical structure of early olfactory processing in mammals. The identification of 4, 6, and 9 modular decompositions suggests a multi-level organization

within the olfactory system. Specifically, the 4 modules may correspond to zones correlated with receptor gene expression in the olfactory epithelium, while the 6 modules hint at further sub-organization within the olfactory bulb. Finally, the decomposition into 9 modules provides a promising framework for understanding the combinatorial basis of the olfactory code in general.

By elucidating this spatial alphabet in rodents, we pave the way for future studies to explore the intricate interplay between neural activity patterns and perceptual experiences in humans.

P244 EPR and NMP responses to the activation of different trigeminal receptors

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Aim While different odors could selectively activate different trigeminal receptors, there is limited research exploring associated responses on psychophyscial and electrophysiological levels.

Methods We recorded negative mucosal potential (NMP) from the respiratory mucosa in 24 healthy participants (25±3 years, 17 women) and EEG-derived event-related potentials (ERPs) from 17 participants (27±4 years, 12 women) during exposure to an olfactory or five trigeminal stimuli, each predominantly activating different trigeminal receptors. Carvacrol was used to activate TRPV3, pereilla aldehyde for TRPA1, isopulegol for TRPM8, cyclohexanone and CO2 for TRPV1, and phenyl ethylalcohol as an olfactory stimulus. Data were analyzed in the time domains. The generalized estimating equation model was employed to compare responses to the different trigeminal stimuli.

Results We found significant differences between trigeminal stimuli in NMP amplitudes and latecies (Wald=13.3 to 48.5, p's<0.01), with Cyclohexanone exhibiting greater amplitudes than Carvacrol, Pereilla aldehyde, and Isopulegol (p's<0.05), and longer latencies than Pereilla aldehyde (p's<0.01). CO2 also showed a greater NMP amplitude compared to Isopulegol and a longer latency compared to Pereilla aldehyde (p's<0.05). ERPs showed significant channel×odor interactions in amplitudes (Wald=32.14 to 67.45, p's<0.01), with CO2 displaying higher amplitudes than Carvacrol and Pereilla aldehyde (p's<0.05), as did Cyclohexanone compared to Carvacrol and Pereilla aldehyde (p's<0.05).

ConclusionsActivation of various trigeminal receptors elicits different peripheral and central electrophysiological responses. Notably, stimulating the trigeminal TRPV1 receptor, associated with the perception of irritation, induces more robust central and peripheral neural activity compared to other receptor activations, even when controlling for stimulus intensity.

P245 Sensitivity of human sweet taste receptor subunits T1R2 and T1R3 to heavy water, and sugars.

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The sweet taste receptor can recognize numerous ligands and is expressed not only in the oral cavity but also in other extraoral tissues, where it exists as either a heterodimer or a homodimer.

Deuterium oxide (D_2O) is water in which the heavier and rarer isotope, deuterium, replaces both hydrogens. We have previously shown that D_2O possesses a distinctly sweet taste, mediated by the T1R2/T1R3 sweet taste receptor. We investigate the impact of heavy water on the T1R2 and T1R3 subunits. Our findings reveal that D_2O activates T1R3 similarly to heterodimer. Mutations in the transmembrane domain (TMD) of T1R3 impair or diminish activation by D_2O, indicatIng a critical role for the T1R3 TMD in relaying the D_2O signal.

We aimed to understand the contribution of each of the sweet receptor subunits to variety of sweet ligands. We have demonstrated that L-glucose, the non-caloric enantiomer of D-glucose, activates the human sweet taste receptor. We show that D and L-glucose, can activate T1R2 and T1R3 transfected without the partner subunit in dose–response but with distinctly different curve shapes. Furthermore, we found disaccharides that strongly activate T1R2, and act as weak partial agonists of T1R3.

These findings offer novel insights into the independent activation abilities of each of the two receptor subunits and may contribute to understanding the physiological roles of extraoral taste receptors.

P246 Fear conditioning biases olfactory stem cell receptor fate

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The main olfactory epithelium initiates the process of odor encoding. Recent studies have demonstrated intergenerationally inherited changes in the olfactory system in response to fear conditioning, resulting in increases in olfactory receptor frequencies and altered responses to odors. We investigated changes in the morphology of the olfactory sensory epithelium in response to an aversive foot stimulus. Here, using two distinct ligand-receptor pairs, we achieve volumetric cellular resolution to demonstrate that olfactory fear conditioning increases the number of odor-encoding neurons in mice that experience shock-odor conditioning (F0; n=11,12; p<0.001), as well as their naïve offspring (F1; n=12,14; p<0.001). Using EdU-labeling to measure birth rates of olfactory sensory neurons, we provide evidence that biased stem cell receptor choice contributes to these increases in F0 (n=6,6; p<0.001). Interestingly, we do not obse”ve t’e inheritance of active avoidance of the conditioned odor, contrary to prior studies demonstrating inherited behavior changes. Thus, we reveal dynamic regulation of the main olfactory epithelium receptor composition in response to olfactory fear conditioning, providing insight into the heritability of acquired phenotypes.

P247 Impact of temperature on salt taste perception and cortical neural responses.

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The experience of consuming food and beverages results in multimodal sensations that involve the integration of intraoral gustatory, retro nasal olfactory, and somatosensory cues that all contribute to the percept of flavor. Human psychophysical studies that have focused on just the gustatory and somatosensory cues have shown, although equivocal, that temperature can influence taste perception and contribute to food and beverage preferences that influence how much we eat.

For example, if temperature alters the perceived intensity of table salt (NaCl), this could result in a diet high in sodium which can cause serious health consequences such as high blood pressure, stroke, and other cardiovascular issues that can increase the risk of, or even cause, death. Therefore, it is crucial to investigate how temperature modulates salt sensitivity and influences the central salt representation in behaving mice.

Here, we used a behavioral two-response taste detection task and electrophysiological recordings from electrodes and silicon probes to investigate how temperature modifies the sensory-discriminative properties of sodium (NaCl) and non-sodium (KCl) salt taste. We found that 1) the mice had higher detection thresholds when both salt solutions were presented at 14°C compared to when they were presented at 36°C and 2) temperature strongly impacts NaCl and KCl concentration coding in the gustatory cortex (GC).

These results obtained in mildly water deprived mice, imply that temperature massively shapes the salt responses of GC neurons, and that colder salty foods and beverages might be harder to detect compared to warmer salty foods and beverages.

P248 Direct determination of multiple ligands interactions with the domains of calcium-sensing receptor

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Kokumi substances, which is glutathione (γ-Glu-Cys-Gly, GSH) and γ-glutamyl-valyl-glycine (γ-Glu-Val-Gly), have been shown to enhance the intensity of basic tastes, such as salty, sweet, and umami, but had no taste themselves at the concentrations tested. We have previously found that various kokumi substances activate the calcium-sensing receptor (CaSR) and have a taste-enhancing function in a CaSR-dependent manner. However, it remains unclear how recently identified kokumi substances such as γ-Glu peptides bind to CaSR and their activation modes. In this study, we generated several site-directed mutated CaSRs and examined them in transiently transfected culture cells to identify their binding sites based on their altered responsiveness to γ-Glu peptide. We found that the γ-Glu peptides containing γ-Glu-Val-Gly bind to CaSR in the same binding region as amino acids. Additionally, it was also found that γ-Glu-Val-Gly acts as a positive allosteric modulator, enhancing the agonism of calcium ions for CaSR. The present study gives insight into a framework for functional properties of CaSR by kokumi substances.

P249 Central processing of food-related odors is affected by PROP taste sensitivity

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Gustatory stimuli are primarily processed in the insula while odors in the piriform cortex. However, less is known on where food odors are integrated and processed in the brain, or if taste sensitivity plays a role. The main aim of this study was to evaluate the association between olfactory and gustatory central processing in healthy subjects. Using a 3T MRI scanner 47 healthy, right-handed females (mean age:

26.2 ± 4.7 years) with a normal sense of taste and smell underwent functional scans. During analysis we presented isointense odors (2 “sweet”, 2 “sour”, 2 “neutral”) to subjects using computer based olfactometry. Odor delivery (8s) was alternated with odorless air (12s) blocks repeated 10 times. Between each session, participants were asked to associate a taste to the odor. Based on intensity ratings for 6-n-prophylthyouracil (PROP), 14 participants were classified as PROP non-tasters (NT), 33 as tasters (T). Subjects predominantly associated a sweet taste to caramel and marshmallow odors (83% and 72%, respectively) while grapefruit and quinine were mostly associated to sour taste (55% and 49%, respectively). T demonstrated greater brain activation in differentiating categories If odors, specifically in the area of Inferior Frontal Gyrus and Orbital Frontal Cortex, while the difIerentiation was not differen” for’IT. In addition, sweet and sour odors elicited a higher level of activation of Inferior Frontal Gyrus and bilateral Caudate. These results on interactions between smell and taste help explain inter-individual differences in odor perception.

P250 Smell Memories: Exploring Memories through Digital Olfactory Training

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Smells trigger autobiographical memories (De Bruijn and Bender, 2018). As compared to other memories, memories triggered by smells are especially emotional, engaging, and accompanied with feelings of being taken back in time (Arshamian, 2013; Willander and Larsson, 2007). Olfaction has a direct connection with the memory regions of the brain (Olofsson et al., 2020). Amores et al. (2023) have illustrated that an olfactory stimulus has a positive impact on memory recall. Recent studies have underscored the beneficial effects of regular Olfactory Training (OT) on memory (Vance et al., 2023).

In our feasibility study, we investigate how participants with various levels of smell ability engage with a digital OT solution, exploring challenges, motivations, etc. The solution comprises a smell-dispensing device and a companion App developed by OWidgets (OW Smell Made Digital). Participants are asked to undertake OT twice daily for 6 months and are encouraged to share insights from their experiences including memories associated or triggered by scents.

Acknowledging the connection between OT and memory, participants are encouraged to do each session mindfully, focusing on memories linked to the smell. At the 4-month mark of the deployment, participants are interviewed on smells and memory. We delve into the participants’ experiences of remembering memories through smells before and after smell loss/disorders and strategies that they have developed to evoke memories that used to be triggered by smells. We highlight qualitative data on how memory is affected by olfactory dysfunction and promote a future culture of smell care.

P251 Effects of Daily Exposure to Unfamiliar Odors on Human Perception: Odor familiarity changes regardless of the presence or absence of long-term memory.

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Objective:

This study aimed to explore the effects of continuo’s exposure to unfamiliar odors in humans' daily lives on their subsequent perception of those odors.

Methods:

Ninety-five participants (47 females and 48 males) were randomly assigned one of two unfamiliar odors with moderate intensity and neutral pleasantness. For eight weeks, they were tasked with sniffing their assigned odor every day at home during a relaxing time after bathing.

In the laboratory, both pre- and post-tests were carried out. Participants were presented with two odors; one odor that they had smelled daily for 8 weeks, and another unfamiliar odor. They were asked to subjectively evaluate their perception of the odors (intensity, pleasantness, familiarity, anger, and disgust), and measured physiological indicators (salivary amylase and heart rate).

Results and Discussion:

Following the eight-week of odor exposure, participants evaluated the odors subjectively. The findings: odor familiarity encountered daily was increased significantly, and declined for odor not encountered. The intensity of daily-exposed odor exhibited not statistically change, while a significant decrease was observed for unexposed odor. Furthermore, irrespective of exposure, there was an elevation in pleasantness rating in the post-test.

Moreover, extracting only the participants capable of distinguishing daily-exposed odor, amplified perception trend emerged in the post-test evaluations. Although to a lesser extent, a similar trend was observed among participants unable to differentiat’ odors.

Thus, regardless of participants' ability to distinguish odors, familiarity with the daily exposure odor increased, while it decreased for odor not exposed, while indicating a decline in familiarity with unexposed odor.

P252 Relationship Between Brief Self-Administered Waterless Empirical Taste Test™ (27- WETT®) Scores and Electrogustometric Thresholds

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The sense of taste is a key arbiter for the oral acceptance or rejection of foods and beverages, impacting quality of life, nutrition, and safety. Tests based upon electrogustometry (EGM) and tastants embedded in disposable monomer cellulose pads are both practical and useful in clinical settings. In this study of 50 healthy subjects, we correlated bipolar anodal EGM threshold scores to scores on the 27-item version of the Waterless Empirical taste Test (WETT®). Both the left and right sides of the anterior tongue were separately evaluated, along with 4 EGM stimulus durations (0.5, 1.0, 1.5 and 2.0 seconds). Correlations between average EMG threshold values and WETT scores were moderate, but significant ($p < 0.001$), for citric acid ($r = -0.43$), sucrose ($r = -0.35$), and caffeine ($r = -0.33$), but not for NaCl ($r = -0.05$) and monosodium glutamate ($r = -0.15$). These data suggest that electrogustometry is associated with taste qualities in addition to those induced by peripheral ionic processes.

P253 Deciphering the neuronal logic of odor classification

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Odor classification is crucial for survival, as odors perceived as appealing predict rewards, while those perceived as aversive signal threats. However, the transformation of olfactory information from chemical to biologically relevant signals remains unclear.

We propose that the assignment of odor valence is ingrained within specific, molecularly identifiable cell types or regions within the olfactory bulb (OB). To test this hypothesis, we aim to correlate odor behavior with molecular cell types within the OB. For our studies, we utilize larval zebrafish as a model due to their external development and the feasibility of examining their entire OB at both functional and molecular levels.

Initially, we assessed larval behavior in response to a variety of odors and classified their preferences. Our findings indicate that nucleic acids elicit strong reactions, bile acids are perceived as appealing, and amino acids provoke a range of behaviors. Moreover, we observed that higher concentrations of odors amplify responses, and certain odors induce delayed reactions. To map the spatial location of odor-responsive cells, we analyzed OB activation patterns using the CaMPARI indicator. We found that odors with similar valences elicited comparable activation patterns.

Additionally, single-cell RNA sequencing revealed remarkable OB molecular diversity, suggesting potential new cell types. To associate these molecular profiles with functional responses, we are applying spatial transcriptomics to map molecularly defined areas within the OB. By integrating behavioral data with functional and molecular analyses, we are laying the groundwork to elucidate the role of the OB in odor processing.

P254 Distinct Cortical Population Dynamics Underlying Learned and Non-learned Aversive Behavior

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Rapidly detecting, processing, and responding to potentially harmful tastes is important for survival. The most basic of these responses is ‘gaping’—an easily-observed oral behavior that serves to push the taste out of the mouth. Gustatory cortical (GC) activity underlies gaping *in situ*: GC ensemble responses progress through a series of coherent firing-rate states in the 1.5s following taste delivery such that firing encodes first taste identity and then its hedonic value (i.e. ‘palatability’); the onset of palatability-related firing both precedes and drives gaping to naturally aversive quinine. Gapes to naturally appetitive tastes rendered aversive by pairing with illness (a form of learning called conditioned taste aversion, or CTA), meanwhile, appear similar in form to quinine gapes, but it is possible that the two might be distinct behaviors underlain by distinct neural mechanisms. Here, we tested these hypotheses. Rats received passive deliveries of 0.1% saccharin via IOCs, and 30min later, were injected with 0.6M LiCl. Twenty-four hrs after CTA training, rats were given aliquots of saccharin and quinine. During both CTA training and testing, GC activity (via 32-channel electrodes) and mouth movements (via electromyography of the anterior digastric muscle) were simultaneously recorded. Preliminary results show that learned gapes have an earlier onset than naïve gapes, but that the second GC firing rate state has the same onset for

both tastes, suggesting that either palatability-related firing occurs in an earlier state during conditioned taste processing or GC activity is not at all required for conditioned gaping.

P255 The Effects of "Sweet" and "Sour" Label Descriptors on the Perception of Flavors and Odors

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Verbal labels exert a top-down influence on olfactory and taste perception. Prior research has demonstrated that when odors are described using non-veridical labels, perceptual judgements of the odor are accommodated to align with the verbal descriptor. It is less understood whether these effects extend to taste, rather than odor descriptors. In two experiments, we examined how labeling tastes and odors as "sweet" vs "sour" influenced perceptual judgements. In addition, we tested whether the timing of the presentation of verbal descriptors influenced perceptual ratings of taste and olfactory stimuli. We hypothesized that taste descriptors presented prior to tasting/smelling may prime the perceptual process, while labels presented after tasting (but before rating) may not influence evaluations to the same extent. In Experiment 1, participants (N = 57) tasted and evaluated eight flavors each presented twice, once with a "sweet" label and another with a "sour" label. Participants saw the flavor labels either before ingesting the solution, after ingesting the solution, or not at all. In Experiment 2, participants (N = 50) smelled, but did not taste, the same solutions used in experiment 1. Participants in both experiments rated each stimulus for pleasantness, familiarity, intensity, sweetness, sourness, and liking. Both experiments found that these perceptual judgements were altered to be congruent with the given label. Perceptual judgements were influenced by "sweet" or "sour" labels regardless of whether the label was provided before or after tasting/smelling the sample.

P256 Olfactory Scene Segregation in Freely Moving Mice

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Animals are constantly bombarded with stimuli from their environments. To effectively perform behaviors that aid in survival and reproduction, animals must be able to discriminate salient cues. In olfaction, relevant odors change drastically across different odor environments and positions from the source. To investigate **how mice pick out trained target odors from variable backgrounds**, we developed a freely moving two alternative forced choice assay where mice were exposed to mixtures of up to 16 odors alongside one of two target odors. This results in over 60,000 unique background odorant combinations. Despite this complexity, we found that mice could identify target odors with over 85% accuracy. Performance on this task increased across training days, providing evidence of an experience-dependent change in odor processing or task learning. To understand **how mice pick out changing salient cues**, we lowered the concentration of the target odor in the presence of the previously outlined, highly variable backgrounds. When target odorant concentration was logarithmically decreased from the training concentration, performance worsened following a sigmoid function. This pattern of performance decrease remained when mice were trained on different target odors, but maximal performance was dependent on odor identity. Ongoing work is investigating how mice implement different behavioral strategies across training to learn odor salience and parse it from backgrounds. Further studies will examine whether and

how neural representation of salient odors in olfactory processing areas, like the piriform cortex and olfactory tubercle, change across learning.

P257 A novel shape-based alignment strategy for modeling structure-activity relationships of receptor-ligand interactions

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Modeling how a system detects a stimulus based on its chemical structure is a critical challenge in chemosensory research. In olfaction, a popular approach for studying inputs to the system makes use of psychophysical reports of olfactory perception; this leverages system-wide sampling but offers limited utility for exploring the relationships between stimuli and chemosensory receptors. When we can directly record the activity of sensory neurons across a system, such as vomeronasal sensory neurons (VSNs) of the mouse accessory olfactory system, we can probe receptor-ligand interactions on a syItem-wide”scal’. A focus of our rIsearch is to develop computational tools inspired by drug discovery techniques which use recordings of VSNs to model structure-activity relationships for receptor/ligand pairs. For this purpose, both ligands and receptors can be represented as pharmacophore models – 3D collections of chemical functional groups that provide an intuitive description of the most relevant features for binding – which provide a ready framework for assessing shape-based similarity of ligand/ligand or receptor/receptor pairs as well as predicting activity for receptor/ligand pairs. We have developed a strategy for rapid, optimal overlay of pharmacophore models that combines a branch-and-bound optimization approach with a novel scheduling algorithm which prioritizes a balanced approach to the explore/exploit tradeoff in optimization. This strategy exhibits favorable accuracy compared to established alignment methods and can be extended to be used with physical force fields (e.g. Lennard-Jones, Coulomb). Our work provides a flexible tool for analysis of receptor-ligand interactions, laying a foundation for further advances in chemosensory research.

P258 Exploring the role of selective attention to odor in decision rule representation

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Adaptive behavior requires the ability to selectively attend to relevant information in complex environments and use this information to guide optimal decisions. Animal studies suggest that that the mediodorsal thalamus (MDT) is a critical region for facilitating attention-guided rule representation in prefrontal cortex. Human neuroimaging studies point to a role for connectivity between MDT and both olfactory sensory cortex and prefrontal cortex in selective attention to odor stimuli. However, the relationship between attention-modulated MDT connectivity and neural representation of task rules in prefrontal cortex has not been established in humans. Here we aim to shed light on this neural process using an attention-guided two-alternative forced choice task. On each trial of the task, participants are first cued to attend to either olfactory or auditory information, and then are simultaneously delivered one of two distinct odors and one of two distinct tones. The identity of the attended stimulus determines which of two subsequently presented choice options leads to a monetary reward. Preliminary behavioral results (n = 7) indicate that participants are able to make correct choices throughout the task, demonstrating that they are able to selectively attend to the cued stimulus to make correct choices. By combining this task with fMRI we will be able to establish how functional connectivity between MDT and sensory cortex is

modulated by selective attention. Multivariate pattern-based analysis techniques will be used to relate this connectivity to representation of task rules in prefrontal cortex.

P259 Gene methylatio' affects salivary levels of the taste buds' trophic factor, Gustin protein.

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For more than 40 years, gustin has been described as a trophic factor responsible for the growth of taste buds. We found, in a genetically homogeneous population, that the polymorphism *rs2274333* (A/G) of the gustin gene is crucial for the full functionality of the protein and is associated with taste sensitivity. However, other studies fail to find this evidence. Here we verified if the gustin gene methylation can affect salivary levels of the protein, also concerning the polymorphism *rs2274333*. The gustin gene methylation profiling, performed using a quantitative methylation assay, and the quantification of the gustin protein salivary levels, performed using the semi-quantitative dot-blot technique, were determined in sixty-six subjects genotyped for the polymorphism *rs2274333* (A/G). Fungiform papilla density was also determined. Our results confirm our earlier observations by showing that AA genotypes (who express the functional form of the protein) have a greater density of fungiform taste papillae, whereas the GG genotypes (who express a less functional iso-form) show a lower density. We also found small variations in protein levels in the three genotype groups which can limit the effect of the genotype on fungiform papilla density. In addition, we found an inverse relationship between methylation and protein levels indicating higher methylation associated with a lower amount of protein, mostly evident in AA subjects, i.e. in subjects who are carriers of the functional isoform of protein. Our findings by showing differences in gustin gene methylation could justify the conflicting data in the literature.

P260 The genetic basis of host preference of two biotypes of the northern house mosquito Culex pipiens

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The arbovirus disease vector *Culex pipiens* has two biotypes, Pipiens and Molestus, which are morphologically identical, but differ genetically and behaviourally. While Pipiens has a more ornithophilic host preference, Molestus is more anthropophilic. With habitats changing due to varying climatic conditions and rapid urbanization, these two biotypes show increased rates of hybridization, with the resulting hybrids demonstrating an intermediate host preference, thereby increasing the chances of zoonotic disease transmission. The mechanism that guides the host preference in the two biot"pes 'nd their hybrids is still unknown, but we hypothesise that there is a genetic basis regulating the observed host preference. To test this, female mosquitoes of each biotype were tested in a Y-tube olfactom"ter 'nI an antennal transcriptome was created to identify key genes (particularly chemosensory genes associated with host preference), with key olfactory receptors and odorant binding proteins showing differential expression between the two biotypes. Field collections of wild *Culex pipiens* populations were also conducted to correlate host preference with changes in biotype populations across Europe. Field samples were identified using qPCR as either biotypes or hybrids, and further work includes confirming the presence of the identified chemosensory genes (from the transcriptomic analysis above) to correlate

host preference with the identified genes in wild *Culex pipiens* populations. Our results highlight a new avenue for research into the host preference of a major European disease vector, as well as the changing mosquito population dynamics across Europe.

P261 Deciphering the molecular basis of pheromone receptor specificity in Spodoptera littor–is

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In the crop pests *Spodoptera littoralis* and *S. litura*, the major component of the sex pheromone blend is (*Z,E*)-9,11-tetradecadienyl acetate, which is lacking in other *Spodoptera* species. It indicates that a major shift occurred in their common ancestor. It has been shown recently in *S. littoralis* that this compound is detected with high specificity by an atypical pheromone receptor, named SlitOR5. Each insect species has evolved its own repertoire of ORs to satisfy its ecology, essentially through duplication events. Duplicates vary significantly in sequence identity and tuning breadths. However, how the duplicates diverged and acquired new functions is not known. We evidenced a duplication of OR5 in a common ancestor of *S. littoralis* and *S. litura* and found that in these two species, one duplicate is also broadly tuned while the other is specific to (*Z,E*)-9,11-tetradecadienyl acetate. By using ancestral gene resurrection, we found that the narrow tuning evolved only in one of the two copies issued from the OR5 duplication. Finally, we identified eight amino acid positions in the binding pocket of these receptors whose evolution has been responsible for narrowing the response spectrum to a single ligand. The evolution of OR5 is a clear case of subfunctionalization that could have had a determinant impact in the speciation process in *Spodoptera* species.

P262 Enhanced Excitability of Accessory Olfactory Bulb Mitral Cells Supports Heightened Intermale Aggression

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Intermale aggression is a highly-conserved behavior that is strongly influenced by social history among other factors. In mice, aggression relies on chemical cues detected by the vomeronasal system, but whether plasticity within these circuits supports experience-dependent changes in aggressiveness is unknown. We previously found that electrophysiological properties of accessory olfactory bulb mitral cells (AOB MCs) are shaped by salient life events such as mating. Here, through *ex vivo* whole-cell recordings and *in vivo* calcium imaging, we address how AOB MCs support flexible intermale aggression. First, *ex vivo* recordings reveal that AOB MCs require less input to evoke action potentials in aggressive vs. non-aggressive males, and maintain robust spiking activity more effectively across repeated activations. To ensure balanced histories of sensory experience, we next performed these recordings in pairs of male mice that formed a dominance hierarchy through daily social defeat sessions over 10-15 days. Such recordings reveal that AOB MCs of dominant males also maintain spiking activity more persistently than neurons of the submissive partners. These results suggest that even within this early sensory area

aggression levels co-vary with cellular properties that can modulate the transmission of social information to limbic areas. In ongoing work, we are targeting *ex vivo* recordings to male-responsive AOB MCs to determine how sensory tuning intersects with electrophysiological properties. Finally, to define how the cellular plasticity we observe shapes sensory responses during behavior, we are also imaging AOB MCs *in vivo* to define how responsiveness to social stimuli adapts as males acquire or lose aggressiveness.

P263 Deciphering Chemosensory Communication in the Castor Bean Tick, Ixodes ricinus

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In the world of ticks, climate change is orchestrating a silent upheaval, propelling *Ixodes ricinus*, the castor bean tick, on a northward migration. This versatile arthropod serves as a primary vector for diseases affecting humans and animals worldwide. Rising temperatures are intensifying its impact. The increasing incidence of tick-borne diseases in Europe underscores the urgency of studying the distributional ecology of I*. ricinus* in response to global warming. Ectothermic arthropods like ticks thrive in warmer environments, expanding their reach and altering disease dynamics. Within this context, chemical communication mechanisms are crucial.

Remarkably, chemical communication studies have primarily focused on insects, with limited attention to ticks. This project sheds light on *I. ricinus* and its chemical communication, addressing this knowledge gap. This project aims to identify and functionally characterize Ionotropic and gustatory recep'ors that might play a crucial role in ticks' olfaction. We have sequenced and analyzed transcriptomes from different body parts of female and male adults (including mouthparts, forelegs, hind legs, and rest of the body) and the whole body of nymphs of the *I. ricinus*. We have identified some gustatory and ionotropic receptor genes and compared their expression levels. Enhancing our understanding of these mechanisms can lead to more effective tick control strategies and disease prevention in our changing world.

P264 Niche Utilization and Cooperative Behaviors in Sympatric Drosophila melanogaster and Drosophila simulans

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Where to lay the eggs is a crucial decision for female insects as it influences the success of their offspring. One important factor in the decision-making process shared by many insects is the desire to minimize the risk of predation, competition, and even the possibility of cannibalism. Significant gaps exist in our understanding of whether females from distinct co-occurring *Drosophila* species exhibit a preference for ovipositing together within the same site when presented with multiple options. Here we tested oviposition strategies of *Drosophila melanogaster* and its close relative *Drosophila simulans* in different conditions, to assess whether they would prefer to oviposit separately or together with another female, and if the latter, whether it matters if the other female is a conspecific or not. Our results suggest that ovipositing females, regardless whether they are conspecifics or not prefer to oviposit at the same site. Interestingly, when testing one fly after the other, this preference for the same site is lost. This behavior might facilitate intra- and interspecific social feeding of same age offspring. However, if eggs are already present, the danger of competition or cannibalism by slightly older larvae potentially outcompetes

any advantages from social feeding. *Drosophila* females, hence, seem to display a cooperative behavior when ovipositing among other individuals, even from a different species, but when one individual comes after the other, they tend to opt for alternative oviposition sites instead.

P265 Opposite Effects of Olfactory Receptors on Transient Receptor Potential Vanilloid 1 Activation by Capsaicin-Type and Eugenol-Type Ligands

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Olfactory receptors (ORs) and transient receptor potential vanilloid 1 (TRPV1) are both found in olfactory sensory neurons (OSNs). The interaction between these two receptors, however, remains largely unexplored. Using HEK293T cells co-expressing tRPV1 and OR, we examined the influence of ORs on the Ca^{2+} influx mediated by TRPV1 after its ligand stimulation. Interestingly, ORs enhanced the response of TRPV1 to capsaicin but diminished that to eugenol. Based on susceptibility to the effects of ORs, we could classify various TRPV1 ligands into two types: capsaicin and eugenol types. An adenylate cyclase activator, forskolin (FsK), exhibited almost identical effects as ORs on TRPV1 responses to both types of ligands. Besides, the modulatory activities of FSK were inhibited by a protein kinase A (PKA) inhibitor. Furthermore, TRPV1 mutants at the known PKA-dependent phosphorylation sites were insusce"tibl' to the modulations of FSK. These results indicate that OR alone activates the cAMP production"path'ay, leading to the phosphorylation of TRPV1 by PKA. It is strongly inferred that this phosphorylation amplifies the susceptibility of TRPV1 activation by both ligand types to the modulations of ORs and FSK. The analysis of various vanilloid compounds suggests that the interaction of TRPV1 with the chemical groups corresponding to the 'neck (amide bond)' and 'tail (hydrocarbon chain)' of capsaicin plays a crucial role in classifying TRPV1 ligand types. Our results suggest that the interaction of ORs and TRPV1 alters their signal transductions depending on TRPV1 ligands in not only HEK293T cells but also OSNs.

P266 Renewing odorants during olfactory training: an efficient strategy to improve olfactory perception, cognition and well-being in the elderly?

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Normal aging is characterized by a global decline in cognition and sensory acuity, including olfaction. Over 25% of individuals aged over 50 suffer from olfactory deficits, that negatively impact living

conditions, notably through reduced hedonic appreciation of food. Olfactory training has emerged as a promising paradigm to improve olfactory perception in dysosmic patients with various etiologies but remains to be optimized. Olfactory training may also have broader cognitive benefits that require further characterization.

In this study, we first examined how saliency and renewal of stimuli during olfactory training improve olfactory perception and quality of life in the elderly, emphasizing food appreciation. Second, we investigated the ability of such olfactory training to improve cognition and the underlying neural mechanisms through the potential involvement of the noradrenergic system, as renewed and salient olfactory stimuli are expected to induce repeated stimulations and preservation of the noradrenergic system. Dysosmic and normosmic participants over 55 years old took part in a 4 month-long olfactory training based on odorants' renewal and were compared to control groups trained with a unique odorant. 65 participants were evaluated on olfactory perception (ETOC, Sniffin'Sticks), cognitive performances (cognitive flexibility and visuo-spatial memory tasks), well-being (questionnaires) and food behavior (in a living lab). Activity of the noradrenergic system was assessed using pupillometry during an auditory odd-ball task. This study is ongoing and the results will be presented and discussed in a perspective to better understand the benefits of olfactory training to counteract olfactory deficits and to promote better aging in the elderly.

P267 Role of oral bacterial glycosidases in human flavor perception

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Flavor perception is a multifaceted process influenced by a combination of gustation, olfaction, and somatosensory inputs. This complex integration results in the nuanced experience of food flavors, which is further complicated by the diversity of the oral microbiota. Among the various factors contributing to flavor perception, the enzymatic activity of oral bacterial glycosidases plays an important role in the modulation of taste and aroma. Despite their potential importance in generating aroma molecules from glycosidic precursors, glycosidases in oral bacteria are understudied, representing a significant gap in our understanding of food perception. This study focuses on the role of bacterial glycosidases from oral microbiota such as *Prevotella*, *Streptococcus*, *Veillonella*, *Actinomyces*, and *Granulicatella*, in releasing aroma compounds from food products. The selected oral glycosidases were produced in *Escherichia coli*, purified, and their impact on flavor release was evaluated. Our findings reveal that β-glucosidase from *Prevotella* significantly modify the flavor profile by releasing aroma compounds, underscoring the critical influence of oral microbiota composition on flavor perception. This study enhances our understanding of the biochemical pathways involved in human flavor perception.

P268 Identification of OR6B1 as a fresh perception receptor

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Fresh sensation is a very important element for forming dietary habits and preferences, but the biological perception mechanism is completely unknown because it is a very subjective and ambiguous sensation. As it is known that there are some relationships between dietary habits and olfactory genes, we examined

the GWAS analysis data of Joanne B. Cole et al. (Nat Comm. 2020) and found that the region containing OR6B1 gene was strongly associated with fresh fruit intake, but not with dried fruit, leading to a hypothesis that OR6B1 might be responsible for fresh sensation recognition.

First, we confirmed that OR6B1 responded to the aroma of various fresh fruits in vitro assay and screened OR6B1 agonists from 746 flavor ingredients. As a result, OR6B1 responded to the ingredients such as aldehydes, which are known to confer freshness to fruits. Interestingly, it also responded to those which add freshly-baked or freshly-fermented sensation to bread or butter. This result was completely consistent with above-mentioned GWAS data, on which the region containing OR6B1 gene was also associated with breads and butter intake, following fruits intake. In fact, we could detect OR6B1 response to freshly-baked bread and freshly-fermented butter.

Finally, we identified OR6B1 antagonists and organoleptically showed that the blockage of OR6B1 hindered the fresh sensation and that the strength of OR6B1 response was corresponding to that of fresh sensation to some extent.

Overall, we concluded that fresh sensation is recognized by OR6B1 and freshly made sensations of processed foods are biologically equivalent to that of fruits.

P269 Expression sites of class I and class II odorant receptors in the olfactory organ of two freshwater turtles: Mauremys reevesii and Trachemys scripta

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The olfactory organ of turtles consists of the upper chamber epithelium (UCE) and lower chamber epithelium (LCE). Based on the presence or absence of associated glands and their topographic arrangement, the UCE is considered to be the air nose, which is receptive to odorants mainly in the air, and the LCE is considered to be the water nose, receptive to odorants mainly in the water. Odorant receptors (ORs) are a family of olfactory receptors and classified into class I and class II based on their primary structure. Numerous class I and class II ORs have been reported to exist in the turtle genome. In this study, we examined the expression sites of ORs in the olfactory organ of ’wo species of freshwater turtles: the Reeve's turtle *Mauremys reevesii* and the red-eared slider *Trachemys scripta*. In situ hybridization analysis showed that, in both turtles, ORs were differentially expressed between UCE and LCE; class I ORs were predominantly expressed in the LCE and class II ORs in the UCE. Current results suggest that these freshwater turtles are receptive to airborne odorants via class II ORs in the uCE and to waterborne odorants via class I oRs in the LCE, and that the expression of ORs is the molecular basis for the functional differentiation between UCE and LCE in the olfactory organ of freshwater turtles.

P270 Type 1 vomeronasal receptor expression in the olfactory epithelium and primordial vomeronasal organ of lungfish

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Most vertebrates possess two distinct olfactory organs, the olfactory epithelium (OE) and the vomeronasal organ (VNO). The VNO is not present in teleosts, but is present in most tetrapods with some exceptions such as birds and humans. The expression of olfactory receptors is different between the OE and VNO; for instance, type 1 vomeronasal receptors (V1Rs) are expressed in the OE but not in the VNO in amphibians. The olfactory organ of lungfish, a sarcopterygian fish most closely related to tetrapods, contains a primordial VNO named recess epithelium (RecE), in addition to the lamellar OE similar to the teleost OE. We investigated the V1R expression in the olfactory organ of four species of African lungfish (*Protopterus annectens*, *P. amphibius*, *P. aethiopicus* and *P. dolloi*) and one species of South American lungfish (*Lepidosiren paradoxa*). In all lungfishes, V1Rs were mainly expressed in the basal layer of the lamellar OE, and slightly in the RecE. This observation suggests that the functions of the lamellar OE and the primordial VNO are incompletely separated, and that all extant African and South American lungfishes share this trait. We speculate that V1R expression in lungfish represents an intermediate step toward the complete segregation of V1R expression between the OE and VNO, reflecting the phylogenetic position of lungfish between teleosts and amphibians.

P271 Exploring Gustatory Cortex Decoding of Chemosensory and Thermosensory Oral Stimuli

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The gustatory cortex (GC) has traditionally been studied for its role in processing taste stimuli at a fixed temperature. Neurons in the GC respond to compounds representing different taste qualities and their hedonic value with time-varying and lick-related patterns of activity. However, a growing body of experimental work indicates that GC neurons can also respond to non-gustatory components of oral stimuli, including temperature – a salient feature of the sensory properties of food and beverages. In this study, our objective is to assess the neural saliency of GC neurons in encoding chemosensory taste information at room temperature compared to their responsiveness to oral thermal information, specifically deionized water in the absence of classical taste qualities. To address this question, we recorded spiking activity from over 900 single GC neurons in mice allowed to freely lick to receive four liquid gustatory stimuli or deionized water at different non-nociceptive temperatures. We then employed a Bayesian analysis approach to determine classification scores for spike trains, considering both rate and phase (the time of the spike within the lick cycle) codes in response to the different stimuli. Our findings suggest that a classification approach that primarily relies on rate information, with a secondary contribution from phase, is optimal for distinguishing between gustatory stimuli or water temperature. Surprisingly, we also observed that the number of GC neurons correctly classifying the stimulus is larger for thermal than for chemosensory stimuli, indicating that fluid temperature is more strongly encoded and thus, more “neurally” salient than taste information.

P272 An anatomical and molecular characterization of the Aedes aegypti reproductive nervous system

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Mosquito reproduction is periodic, relying on the intake of a blood meal, proper time to mature eggs, and a suitable egg laying site. Additionally, mosquitoes exhibit reduced attraction to hosts after a blood meal, behavior that is sustained throughout egg maturation until eggs are laid. These observations suggest that neural control may link physiological state of the reproductive system and related behaviors. Little is known about the neurons of the *Aedes aegypti* female's reproductive system, or how their circuitry regulates reproduction-related behaviors. To address this gap, we are characterizing the neurons of the female mosquito reproductive nervous system based on molecular identity and anatomy. Using a combination of transcriptomics, genetic manipulation, and immunofluorescence, we are visualizing the reproductive nervous system and exploring the expression of candidate genes like neurotransmitter biosynthesis markers, ion channels, chemoreceptors, and more. The goal of our work is to contribute to knowledge of the unique reproductive cycles that blood-feeding mosquitoes undergo. We will present updates toward this goal.

P273 Role of CXCR4 in injury-induced olfactory neurogenesis

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The olfactory epithelium is composed of neuronal and non-neuronal cell types and is characteri'ed by sustained neurogenesis throughout one's lifetime. We showed previously that significantly stronger neurogenesis in the olfactory epithelium compared to other neurogenic niches coincides with significantly higher expression levels of the chemokine receptor CXCR4. Moreover, the concentration of the CXCR4 ligand CXCL12 is tightly regulated in the olfactory epithelium.

To establish a more complete understanding of the role of CXCR4 as regulator of postnatal neurogenesis, we monitor constitutive and injury-induced neurogenesis in the olfactory epithelium of CXCR4 cKO animals. Adult mice with targeted deletion of *Cxcr4* in either HBCs (*Krt14-Cre; Cxcr4lox/lox*) or GBCs (*5HT3-Cre; Cxcr4lox/lox*) showed only subtle alterations in the olfactory epithelium. Unexpectedly, Methimazol-induced injury of these mice initially lead to improved regeneration with increased numbers of immature sensory neurons and improved sense of smell. However, after the onset of neurogenesis, CXCR4 cKO causes regenerative failure, resulting in a nearly complete absence of OMP-positive neurons in the dorsomedial part of the olfactory epithelium. Mice with a CXCR4 knockout exhibited a concurrently affected fear response, known to be triggered by these neurons. To further analyze the stage of neuronal development affected by absence of CXCR4 we performed RNA seq analysis of the olfactory epithelium together with computational methods to map the regulated genes.

Taken together, we suggest a possible scenario through which CXCL12-CXCR4 signaling contributes to establishing the axon extension or projection in the olfactory epithelium.

P274 Investigating the role of human mediodorsal thalamus in odor-guided behavior

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In order to perform critical functions like obtaining food, avoiding prey, and selecting mates, nervous systems must be able to transform olfactory sensation at the periphery into adaptive behaviors. One key region for coordinating this function is the mediodorsal thalamus (MDT), which is densely connected with

both olfactory sensory cortex and prefrontal substrates. Recent animal studies demonstrate that MDT both encodes information about specific odorants, and mediates connectivity with sensory and prefrontal cortices to guide behavior. However, the mechanisms by which MDT supports odor-guided behavior in humans remain unknown. Here we designed an experiment in which human participants perform an odor-guided learning task while undergoing fMRI. On each trial of the task, participants receive one of three distinct odors and then make one of two possible responses to receive a monetary reward. Critically, in some trial blocks the rewarded response is the same regardless of odor identity, and in other blocks identity determines the correct response. This experimental design allows us to test the primary hypothesis that ensemble MDT activity preferentially encodes information about odor identity when identity is relevant for making a decision. Preliminary behavioral results (*n*=15) indicate that participants make highly accurate choices regardless of block type, and that residual differences in odor pleasantness and intensity do not affect performance. Planned analyses of fMRI data will employ multivariate pattern-based techniques to characterize how the balance of olfactory sensory and behavioral task variables are represented in olfactory sensory cortex, MDT, and prefrontal cortex to support learning.

P275 Cellular and functional heterogeneity of interhemispheric connections in the anterior olfactory nucleus

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The olfactory system in most mammals begins with two unique air flows separated by a nasal septum. Olfactory signals are then relayed to the brain in two separate olfactory bulbs. However, olfactory stimuli are ultimately perceived as one signal. The mechanisms by which the brain combines these separate inputs to obtain perceptual unity remain unknown. The anterior olfactory nucleus (AON) is the earliest olfactory cortical area to project interhemispherically, making it an excellent candidate for the combination of bilateral olfactory information. The AON is implicated in social behavior and olfactory memory. However, the specific cell types involved in the interhemispheric AON connection are unknown, a" wel' as the functional changes within the AON that result from contralateral input. Using anterograde and retrograde anatomical tracing, we show that contralaterally-projecting AON neurons are glutamatergic (*VGLUT1*-positive) but not GABAergic (*VGAT*-positive) (N=3 *VGLUT1-cre* mice, N=5 *VGAT-cre* mice) and synapse with both glutamatergic and GABAergic neurons (N=3 *VGLUT1-cre* mice, N=3 *VGAT-cre* mice). Optogenetic stimulation of contralaterally-projecting AON axons during whole-cell recoding of AON cells resulted in EPSPs with a connection probability of 0.4 (n=10 cells). This work will contribute not just to our understanding of the AON, but also to the processing done by the olfactory cortex. Insights from the cellular and functional diversity within the AON will guide future research on the role of the AON in olfactory-related disorders. This work is sponsored by NIH grant 1RF1NS128865.

P276 NeurONA: Impact of training on olfactory perceptions and memory capacities

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The olfactory perception is a multidimensional approach. It results from several stages, including detection, discrimination, and finally, the recognition and memorization of the odor. Additionally, the olfactory perception is subjective and depends on various individual factors such as age, life experiences,

emotional state, culture, and expertise. Therefore, to enhance olfactory expertise and memory, the implementation of a training process is required. In this context, the NeurONA project has been conducted aiming to investigate the impact of training on cognitive and sensory expertise.

For this purpose, a sensory methodology was performed for 3 years. A total of 47 assessors participated in this study and underwent various types of sensory tests, including (i) the evocation test, (ii) discrimination test, (iii) descriptive test, (iv) memorization test, and (v) categorization test. In this summary, only the results of discriminative and memory tests are described. The analysis of triangulation tests showed an improvement in the ability to detect olfactory differences. Indeed, the number of correct responses (RC) increased significantly comparing different periods T0 (49%), T1 (57%), T2 (59%). A significant decrease was observed at T3 (39%), explained by the effect of the Covid-19 pandemic. A similar trend was noted for the olfactory memorization test, underling the positive effect of training on the olfactory expertise over time.

In conclusion, this study sheds light on the potential impact of learning on cognitive and sensory expertise, highlighting the need for further exploration in the realm of olfaction, emotions, and memory due to various individual factors.

P277 Improvement of sweetness perception through gradual increase in sugar content during the eating process'Ryota Nitto [1]

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In recent years, the excessive consumption of sugar has led to significant health issues, including obesity and diabetes. To mitigate these concerns, various strategies have been explored to enhance sweetness and sweet flavors without increasing sugar consumption. Traditional methods, however, typically rely on a single intake or repetition of the same stimulus pattern, falling to address the decrease in sweetness perception caused by habituation during continuous ingestion.

Consequently, we hypothesized that a gradual increase in sugar content throughout the eating process could reduce the perception of sweetness loss due to habituation and enhance overall sweetness experience. To examine this hypothesis, we developed a device capable of delivering a sucrose solution whose sugar concentration gradually varies.

In the experiment, participants ingested a continuous flow of a 4.7% sucrose solution over a span of 15 seconds. The sugar concIn was altered gradually under three differnt conditions: an increase from 3.8% to 5.6%, a decrease from 5.6% to 3.8%, and a constant condition of no change. Participants were asked to swallow at 3-second intervals, five times in total, and rate the sweetness at each instance. The mean of the five sweetness ratings in each condition was compared.

In the group that showed habituation at a constant sugar level, the mean sweetness improved when the sugar content was gradually increased. These results suggest that the pattern of increasing sugar content can potentially enhance sweetness perception by mitigating the effects of habituation.

P278 Alleviation of the acute stress response on the autonomic nervous system by black pepper essential oil

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Black pepper is a widely used spice globally, but its essential oil has yet to be studied in the context of aromatherapy. This study sought to examine the effects of black pepper aroma on cardiac and peripheral autonomic nervous system (ANS) activity under stressful conditions. A within-participant design experiment was conducted with 20 males who performed a 30-minute calculation task as a short-term stressor under three aroma conditions: black pepper, ginger, and dipropylene glycol (DPG) (scentless air as a control). Each aroma was sporadically delivered for the first 20 seconds of each 1-minute interval using an olfactometer d'ring the task to prevent olfactory fatigue. The ANS's physiological acute stress response was evaluated using electrocardiograms and skin conductance level (SCL). The results showed that the aroma of black pepper suppressed the physiological acute stress response induced by the short-term stressor. The increase and decrease in the heart rate (HR) and the heart rate variability (HRV) accompanied by the stressor were significantly smaller than those in DPG (p = 0.048 in HR and p = 0.002 in HRV). Additionally, the increase in SCL was significantly smaller than that in ginger (p = 0.005). Although black pepper is a stimulative agent, the study findings suggest that the aroma of black pepper can alleviate the physiological acute stress response, making it a potentially helpful tool in aromatherapy under stressful conditions.

P279 Correlation between the functional polymorphisms in TAS2Rs and human bitter taste perception for caffeine

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Some TAS2Rs (bitter taste receptors, taste receptor 2) have genetic polymorphism which suggested to be responsible for interindividual differences of bitter taste sense. TAS2Rs cluster in chromosome 12 is reported to be high association with the bitter sense to coffee and caffeine, including 3 TAS2Rs (TAS2R14, -43 and -46) respond to caffeine. Here, we focus on the coding SNPs (Single Nucleotide Polymorphisms) in TAS2R43 and -46, because TAS2R14 has few SNPs. TAS2R43 and -46 have 2 major haplotypes due to 2 and 1 SNPs, respectively. One is suggested as the ancestral type mainly distribute in Africa and another is suggested as the derived type mainly distribute in East Asia. We examined the effects on their function using the expressed protein in HEK293T cells. We also carried out human tasting test with volunteer subjects to analyze their threshold of bitterness perception with their genotyping data. We found the difference in the reaction to caffeine between the genotypes of TAS2R43 and -46 protein. In both receptors, the ancestral types showed higher response. There was a tendency that people having the ancestral types can detect caffeine bitterness at lower concentration than those having the derived types. Some bitter compounds in coffee were reported to stimulate only TAS2R43 and -46. Therefore, the taste of coffee may be different among the people's TAS2R43/-46 genotypes. Considering the distribution of the haplotypes, these SNPs in the TAS2R43/-46 may be correlated to human evolution spread from Africa.

P280 Taste-related neural activity in the mediodorsal thalamus of mice

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The gustatory cortex (GC), typically studied for its role in processing taste signals, is involved in integrating sensory and reward-related information associated with eating. This integration is attributed to sensory inputs from the gustatory thalamus (VPMpc) and associative-limbic inputs from the basolateral amygdala (BLA) received by the GC. Recent evidence shows that the mediodorsal thalamus (MD), another thalamic region, has reciprocal connections with the GC and encodes signals related ’o flavor. While these findings shed light on the MD's role in flavor processing when chemosensory stimuli are delivered via intraoral cannula, little is known about its role in taste and taste-related expectation in actively licking mice.

Here, we uIe chronic silicon probes to record neural activity in the MD of actively licking mice. Recordings were conducted while mice were presented with different concentrations of taste stimuli s–ch as sucrose, NaCl, citric acid, quinine, or w’ter - all at room temperature. Further, given the MD's involvement in anticipatory responses, we explored its role in specific expectations of rewarding (sucrose) or aversive (quinine) taste stimuli. We found that MD neurons, as single units and ensembles, reliably discriminated taste quality and concentration. Additionally, our results suggest that the MD can encode cues predicting different taste outcomes, with specific expectations leading to distinct anticipatory ’epresentations.

Overall, these data elucidate the MD's role in processing taste-related information and emphasize the need for future studies on this thalamocortical connection.

P281 Towards revealing the molecular mechanisms governing ultra-high affinity interactions between odorants and olfactory receptors

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Olfactory receptors, the largest G protein-coupled receptor family, comprise proteins that recognise odorants in the environment [1,2]. We use computational tools to investigate how the structural fit to the binding pocket differs between different affinity ligands. Recent studies show that ORs can be narrowly tuned to odorants in the sub-picomolar to nanomolar concentration range [3,4].

This study aims to elucidate the molecular me–hanisms underlying high-affinity olfactory receptor - ligand binding. We conducted homology modelling of Olfr1377 (OR1AD1) using a consensus OR1 structure as a template, identified the binding pocket, and validated it using experimental data. Ligand docking was performed using the London and GBVI/WSA dG scoring functions.

Our findings indicate that 4-methoxypropiophenone exhibited the highest binding affinity (kcal/mol) but did not interact with the modelled Olfr1377 residues, suggesting that this is due to a combination of non-covalent forces, shape complementarity, hydrophobic effects, and entropy changes. On the other hand, l4-methoxy-acetophenone (kcal/mol) and acetophenone (kcal/mol) interacted with specific residues, TYR 252 (H-acceptor) and ASN 109 (pi-H). Notably, 4-methyl-acetophenone (kcal/mol) and 2-hydroxy-acetophenone (kcal/mol) exclusively interacted with ASN 109. These ligands experimentally exhibited varying responses to Olfr1377 at low concentrations [3].

Our study extends previous experimental work where 4-methoxy-acetophenone showed the highest binding affinity [3]. However, preliminary experimental findings have confirmed 4-methoxypropiophenone as a strong activator of the 1377 mitral and tufted cells in vivo. Additionally, we observed distinct

interactions with TYR 252 and ASN 109. This enhances our understanding of olfaction and holds potential applications in industry.

P282 Processing of behaviorally relevant odors in the posterior tuberculum of zebrafish: bridging olfactory inputs with behavioral outputs

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Odors are encoded as spatio-temporal patterns of neuronal activity in the olfactory bulb (OB) network. This primary odor representation is conveyed by extensive axonal projections of mitral tufted cells (MTCs) to a distributed network of brain regions. One of these regions, the posterior tuberculum (PT), receives extensive axonal innervation from a broad set of MTCs in zebrafish. In an ex-vivo preparation of lamprey, it has been identified as an important part of a network involved in odor-motor-transformations. In the genetically tractable zebrafish however, odor responses in the PT have not been characterized so far. Using two-photon Ca^{2+} imaging in head-fixed zebrafish larvae, we found that the PT performs a profound transformation of odor responses. As such, responses of PT neurons were more similar to adjacent brain regions, such as the (pre-) thalamic, and hypothalamic areas, than to other target regions of the OB, such as the pallium, subpallium or the habenula. Our observations pave the way to further study the precise role of PT in odor-motor transformations, and the circuit, cellular, and synaptic mechanisms underlying its specific odor response profile.

P283 The effect of unpleasant odor on task performance.

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It has been reported that exposure to mal odors decreases memory task performance (Danuser et al., 2003). In this study, we examined the effects of unpleasant odors (oil odors) generated in a factory on workload and work accuracy. We also examined whether personality traits, such as anxiety sensitivity and difficulty switching attention etc., are related to the way participants are affected by unpleasant odors. The participants were given the task of finding specific toy blocks from a box containing many toy blocks and assembling the blocks in a small tent filled with an odor of oil (oil odor condition) and in an odorless tent (odorless condition). The number of toy blocks that could be found and the number of blocks that could be assembled correctly within a time limit (finding task: 30 sec, assembling task: 60 sec) were compared between conditions. In addition, before and after the task, we asked the participants to rate their moods, such as vigor and fatigue, using a visual analog scale. The results showed that there were no differences in task performance between conditions, but the number of wrong blocks found appeared to be slightly higher in the oil odor condition. There is a slight possibility that in oil odor condition, the more difficult it is for the participants to switch their attention, the greater the number of incorrect blocks they found.

P284 Deciphering Peripheral Taste Neuron Diversity: Using Genetic Identity to Bridge Taste Bud Innervation Patterns and Functional Responses

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Peripheral taste neurons exhibit functional, genetic, and morphological diversity, yet understanding how these attributes contribute to distinct taste neuron types remains unclear. In this study, we aimed to relate peripheral taste bud innervation patterns to the functional characteristics of a neuron type defined by expression of Proenkephalin (Penk). Our analysis revealed that taste arbors (the portion of the axon within the taste bud) stemming from Penk+ neurons displayed diverse branching patterns and lacked stereotypical endings. The range in complexity observed for individual taste arbor from Penk+ neurons mirrored that of the entire population, suggesting that taste arbor morphologies are not primarily regulated by neuron type. Notably, the distinguishing feature of arbors from Penk+ neurons was their propensity to contact different types of taste-transducing cells (Type II and Type III) within the taste bud. This finding is contrary to the expectation of genetically defined taste neuron types that functionally represent a single stimulus. Further investigation of Penk+ neuron function revealed that Penk+ neurons respond to sour and bitter stimuli to a greater extent than the full population of peripheral taste neurons. Penk+ neurons also respond well to high concentrations of NaCl. These stimuli are all innately aversive. Alternatively, Penk+ neurons do not respond well to sucrose or umami, which are not innately aversive. This implies that genetic expression might categorize peripheral taste neurons into hedonic groups, rather than identify neurons responding to a single stimulus.

P285 Investigating the Mechanisms of Enantiomer Discrimination by an Odorant Receptor

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Enantiomers are chiral molecules with identical chemical formulas and atom connectivities but differ in spatial arrangement. These enantiomers, perceived distinctly as odorants by humans and animals, likely elicit different responses from the roughly 400 odorant receptors (ORs) we possess. Yet, the mechanism by which ORs differentiate enantiomers remains elusive. Leveraging recent advances in mammalian OR structures at the atomic level, we adopted a structure-function strategy to explore enantiomer discrimination using consensus OR1 (consOR1), representing family 1 ORs.

ConsOR1 exhibits varied responses to enantiomers such as carvone, menthol, and citronellal in heterologous expression assays. We employed site-directed mutagenesis within the canonical binding pocket, based on its structure, to examine enantiomer discrimination in mutants. Our results show that some mutations altered overall responsiveness without’affecting selectivity, while others modified consOR1's selectivity compared to the wild type. Notably, mutations that altered selectivity for one enantiomer pair did not necessarily affect another, suggesting that key residues for enantiomer distinction are odorant-specific. These findings offer insights into the mechanisms of enantiomer discrimination by the mammalian olfactory system.

P286 Physicochemical properties of odors coded in the early stage of cortical olfactory processing contribute to odor discrimination in humans

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Humans possess a remarkable ability to discriminate between odors, yet the perceptual aspect of odors is often simplified to a‘low-dimensio’al experience, predominantly linked to 'pleasantness'. How does our brain manage to distinguish between odors while simultaneously evaluating pleasantness? Previous studies suggest that the neural representation of odors undergoes a gradual reshaping from that of physicochemical properties to subjectively recognizable perception. Rodent studies suggest a role of the early olfactory processing stage, during which physicochemical properties of odors are coded, in odor discrimination. However, in humans, the processing stage critical for odor discrimination is not well understood. To investigate this, we conducted two experiments where EEG responses to odors were examined using time- and frequency-resolved decoding and representational similarity analysis. We then examined the association of these results with intra- and inter-subject variability in odor discrimination performance. We found that early theta activity encodes the physicochemical properties of odors independently of their pleasantness, while late delta activity encodes pleasantness independently of physicochemical properties. Both intra- and inter-subject variability in decoding performance based on early theta activity were associated with odor discrimination performance. Furthermore, the degree of physicochemical coding observed in early theta activity (200-400 ms after odor onset) was correlated with odor discrimination performance. These results suggest that temporally and spectrally distinct neural activities underlie odor discrimination and perceptual pleasantness. Moreover, the neural coding of the physicochemical properties of odors during the early stages of cortical processing appears to play a crucial role in odor discrimination.

P287 Decoding Human Choice Behaviors Towards Fabric Softener Odors: an fMRI Study Before and After Familiarity

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The potential value of a product includes the positive effects consumers obtain through product use, such as functionality and economic efficiency. Predicting this value before purchase plays a significant role in consumer behavior. Although previous studies have shown that value information is represented in activity in the nucleus accumbens and medial orbitofrontal cortex (mOFC), the mechanisms through which the brain encodes product value before long-term use remain to be elucidated.

To examine the impact of olfactory cues as a factory related to the potential value of a product, we measured brain activity evoked by three odors of fabric softeners using fMRI for two days, approximately four months apart (N = 25). Participants used the same three types of fabric softeners twice at home after the first fMRI experiment (Day 1). Then, participants chose one fabric softener and used it at home until the second day of the fMRI experiment (Day 2).

To identify the regions predicting odor choice behaviors, we conducted a searchlight decoding analysis that distinguished selected and non-selected odors on Day1. Decoding performances were significantly higher than chance at several regions, including the right mOFC and left superior frontal lobe. Next, to investigate whether the decoding performances remain high after daily use, we conducted a similar decoding analysis on Day 2 and found that the left superior frontal showed significantly higher decoding performance. These results provide insights into the neural basis of consumer choice behavior and the influence of product experience on odor preference.

P288 Cross-Decoding Revealed Common Neural Coding Between Odor Perception and Imagery.

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Humans have the capacity to internally generate sensory experiences, a phenomenon known as imagery. In vision, imagery has been shown to activate the visual cortex, with evidence suggesting common neural coding between perception and imagery. Studies have also suggested the existence of olfactory imagery, with activation observed in olfactory regions. However, whether common neural coding underlies imagined and perceived odors remains largely unexplored. To address this gap, we used functional magnetic resonance imaging to measure the brain activities of 25 subjects while they perceived and imagined odors of six daily items. The acquired data was analyzed using a cross-decoding approach. Specifically, we trained a decoding model that predicts the identities of perceived odors based on brain activity during perception and then applied this model to brain activity during imagery to predict imagined odors. We also constructed a model trained with imagery and tested it with perception. If these models accurately predict the odor, it suggests common neural coding between perception and imagery. Remarkably, both models exhibited significantly better-than-chance cross-decoding performance in olfactory regions, including the orbitofrontal cortex and insula, as well as in semantic and visual areas. Further investigation into the nature of information encoded in these regions revealed a significant correlation between the perceptual aspects of odors, rather than semantic aspects, and decoding accuracy in the left insula. These findings suggest that activity in the left insula represents the perceptual aspect of odor information during both perception and imagery, employing a coding scheme shared across both conditions.–

P289 Olfactory sensitivity varies across the globe - evidence from 17 locations

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Variability in human olfactory sensitivity has been attributed to individual factors such as genetics, age, sex, medical history of infections and trauma, neurogenerative diseases, and emotional disorders. Scarce evidence exists on the geographical variation in olfactory sensitivity, with no studies analyzing jointly geographical and individual factors in shaping olfactory sensitivity. To this end, we compared the olfactory sensitivity of individual subjects (n=919) inhabiting 17 locations across the globe (Turkey, Malaysia, Tunisia, Japan, Ira–, Cuba, Argentina, Brazil, India, Australia, Canada - Vancouver, Canada-Trois-Rivieres, China, Poland, Philippines, USA, Italy). To eliminate uncontrolled variance related to specific sensitivity, olfactory thresholds were measured twice with the custom-made 8-step Sniffin' Sticks test filled with an odor mixture. We estimated the variance attributed to the study site and the predictive value of the individual factors known to affect the olfactory system. Results of the present study (1) replicate the previously reported country-specific variance assigning 20.6% of the total variance in human olfactory sensitivity to the study location, (2) demonstrate that age, depressive symptoms, and odor awareness are among individual factors predicting the variability in human chemosensory sensitivity across the study sites, (3) confirm the reliability of olfactory threshold measurements (ICC=.65). We conclude that

geographical factors introduce a unique proportion of variance which needs to be accounted for in consideration of individual differences in olfactory sensitivity. The strengths of the current study involve a robust sample collected via a network of highly qualified chemosensory scientists and the data acquired in populations underrepresented in scientific discourse.

P290 Functional Role of TAS2R43 in Zinc Uptake by Immortalized Human Parietal Cells

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Zinc is an essential micronutrient fulfilling a role in various important functions such as cellular membrane integrity and gastric acid secretion (GAS). By means of a CRISPR-Cas9 approach, we proved bitter taste receptor (TAS2R) ligands to regulate proton secretion as key mechanism of GAS in immortalized human gastric tumour cells (HGT-1). Moreover, TAS2Rs were demonstrated to play a functional role in the cellular uptake of small molecules. Here, we hypothesized TAS2Rs (i) to modulate the intracellular proton concentration in response to zinc exposure as key mechanism of GAS and (ii) to regulate cellular zinc homeostasis in immortalized human parietal cells of the HGT-1 cell line.

HGT-1 cells treated with $ZnCl_2$ (100 – 1000 µM) for 30 min underwent a fluorescence-based analysis of intracellular proton concentration (IPX), ICP-MS analysis for quantitative determination of intracellular zinc, and qPCR experiments to study gene regulation of *TAS2R*s and zinc transporter proteins (ZIP and ZnT). Functional involvement of TAS2R43 was verified in CRISPR-Cas9 *TAS2R43* knock out HGT-1 cells. The expression of selected ZIPs and ZnTs was visualized via immunocytochemistry (ICC).

Treatment of HGT-1 cells with $ZnCl_2$ increased the intracellular zinc concentration and the IPX, and resulted in a gene regulation of several *TAS2R*s. In *TAS2R43*ko cells, a 3.5-fold increase ($p<0.001$) in intracellular zinc concentration, a 21% reduction ($p<0.05$) of the IPX, and a mean 11.1-fold rise ($p<0.0001$) in ZIP14 protein expression was demonstrated via ICC, thereby verifying our hypothesis. Hence, we hypothesize the presence of TAS2Rs to help protect parietal cells from excessive zinc uptake.

P291 The Olfactory Bulb in Semi-Aquatic Carnivores: Insights from the Asian Small-Clawed Otter (Aonyx cinereus)

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This study explores the structural characterization of the olfactory bulb (OB) in the Asian small-clawed otter (*Aonyx cinereum*), a semi-aquatic carnivor' from the Mustelidae family. We have examined the OB's macroscopic and microscopic features, focusing on its two main components: the main olfactory bulb (MOB) and the accessory olfactory bulb (AOB), which are crucial for processin' olfactory and pheromonal information. While the MOB's structure is relatively conserved across mammals, in carnivores, particularly within the Mustelidae family, the development of the AOB exhibits notable differences, underscoring the need for a species-specific approach to study these structures. The Asian small-clawed otter presents an

intriguing model for such studies, given the lack of prior research on its OB and its unique semi-aquatic lifestyle.

Employing techniques such as macroscopic and microscopic dissections, histological staining, and immunohistochemistry, we found a well-developed MOB, indicative of advanced olfactory capabilities. Conversely, the AOB was smaller and less laminated, aligning with findings in other mustelids. However, in the transition area between the main and accessory olfactory areas, known as the olfactory limbus, the presence of atypical glomerular structures whose neurochemical pattern implicates them in the detection of phenomenal signals is remarkable, suggesting a complex orga'izational structure. This study highlights the otter's traditional olfaction significance and suggests the potential for alternative chemosensory integration models, challenging established paradigms based on rodent research. Likewise, this study is key to understanding the adaptive changes experienced by the accessory olfactory system in different groups of mammals.

P292 Impact of Nasopharyngeal Myiasis on Olfactory Function in European Roe Deer (Capreolus capreolus): A Histopathological Analysis

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Nasopharyngeal myiasis in European roe deer (*Capreolus capreolus*) is induced by larvae of *Cephenemyia stimulator*, an Oestridae family fly. These larvae inhabit the upper respiratory tract of the deer, causing extensive tissue damage and clinical symptoms over several months. The lifecycle of *C. stimulator* involves three larval stages, leading to significant pathology in the host. Despite their common occurrence, the histopathological impacts of these larvae on the nasopharyngeal and nasal tissues have not been thoroughly examined. Our research addresses this gap by conducting a detailed histopathological study of the tissues affected by these parasitic larvae. Using various staining techniques, we have uncovered extensive damage in the nasopharyngeal mucosa, including erythematous changes, mucosal metaplasia, fibrosis, and necrosis. Additionally, parasitic cysts and eosinophilic infiltration were observed, indicating severe infestation effects. The lesions observed in the turbinates mucosa of the roe deer are also severe, comprising vacuolization and epithelial degeneration. This results in a loss of epithelial layering and is accompanied by conspicuous eosinophilic infiltration, all of which collectively compromise the olfactory function of the animal.

This study is vital for understanding the consequences of myiasis on roe deer health and has significant implications for wildlife management and conservation strategies. Further research into the ecological and behavioral consequences of olfactory impairment in affected deer populations could provide valuable insights into the broader implications of parasitic diseases in wildlife, highlighting the need for integrated management approaches that consider the complex interactions between host health and parasite dynamics.

P293 Mating experience affects the oviposition preference of female Drosophila melanogaster

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Insects exhibit behavioral changes based on their experiences. It is known that the experience of copulation has a profound effect on the behavior of male *Drosophila melanogaster*, e.g., males perceive ejaculation as a reward and increase their preference for odors they smelled during ejaculation. Courtship conditioning, hence, is a well-established paradigm that however uses primarily male behavior. At the same time, it is not known whether female flies regard mating as rewarding also and are able to learn cues during mating that can influence subsequent behaviors, such as oviposition or remating preference. We hypothesized that *D. melanogaster* females would prefer to oviposit on those substrates they have mated on. Indeed, when females were mated on a particular substrate, their subsequent oviposition preference for that substrate increased significantly. Moreover, when females were either anosmic or during mating experienced only the headspace of the substrate, they did not change their oviposition preference upon mating. Apparently, olfactory input is needed but not sufficient for the mating-induced change of preference. Ongoing experiments shall reveal whether the mating experience changes not only the female's oviposition preference but also its mating preference when choosing another male later.

P294 A Sodium-dependent Glucose Co-transport Protein (SGLT) is not Required for Detection of Glucose Taste in Humans

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Sweet taste signaling is known to be mediated primarily by the TAS1R2/TAS1R3 heterodimer GPCR. Recent evidence has suggested the existence of an alternative sweet taste signaling pathway for metabolizable saccharides, such as glucose, dependent on an SGLT in humans. We previously reported development and validation of an automated, rapid throughput taste discrimination assay for humans (TāStation®) to characterize sweet taste concentration-dependence of TAS1R2/TAS1R3 agonists (Palmer et al, 2021, JPET, 377:133-145). We now have used this approach to pharmacologically interrogate the proposed alternative sweet taste signaling pathway. Groups of 10 subjects participated in experiments designed to determine the discriminability of 5 different randomly presented concentrations of glucose (20, 40, 60, 80 and 100 mM; 12 trials each per test per person) from aqueous vehicle (36 trials per test per person). The basic design was repeated with vehicles of water, 20 mM NaCl, 0.2 mM phlorizin, 20 mM NaCl+0.2 mM phlorizin, and 20 mM NaCl+10 µM mizagliflozin. Signal detection analysis of the resulting datasets yielded d' values for discriminability of 20 mM glucose ranging from 0.71-0.91 across all conditions, indicating that this concentration was near detection threshold. No effects of SGLT inhibitors or 20 mM NaCl on the discriminability of 20 mM glucose were statistically detected. Further glucose concentration-response analysis yielded functions with taste-active ranges well beyond the reported range of SGLT glucose-dependent transport activity. Lactisole (1 mM) blocked glucose taste of concentrations 250 mM and below. We conclude that glucose taste is entirely explained by agonist activation of TAS1R2/TAS1R3.

P295 Neural and behavioural mechanisms of olfactory decision reversals

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In nature, sensory inputs are often noisy and dynamic, affecting perceptual decision-making and reversals. Cognitive flexibility further adds to the complexity. Decision reversal allows switching between available choices and/or cessation of already initiated, context-inappropriate, misconstrued responses. In the present study, we aimed to quantify such misconstrued behavioural responses and the underlying neural mechanisms. Mice were trained on an olfactory go/no-Go decision-making task to distinguish

between rewarded and unrewarded stimulus. Initially, they lick in response to both stimuli; however, as training progresses, licking for unrewarded stimuli diminishes. Despite reaching an accurate performance level (i.e., >80%), for a few non-rewarded trials, they lick and stop within a few milliseconds. We conclude this phenomenon as decision reversal (DR). Such trials comprised 5-25% of the high-performance trial blocks, usually occurring within the first 500 ms of the stimulus epoch. Furthermore, reversals were more frequent in binary mixture discriminations than monomolecular ones. Upon enhancing the inhibitory synaptic signalling in the olfactory bulb by photoactivating the ChR2-expressing GABAergic granule cells, we observed faster odour discrimination and fewer reversal trials. We are now trying to delineate the role of excitatory projection neurons in reversal phenomena.

P296 Taste adaptation facilitated by glia-like type I cells

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The sense of taste generally shows diminishing sensitivity to prolonged stimuli, referred to as taste adaptation. Yet, its mechanistic landscape remains incomplete. While the desensitization of sensory receptors is a widely recognized mechanism mediating adaptation, our investigation reveals a novel player in the process – glia-like type I cells, once considered mere bystanders in the taste bud. Type I cells exhibit an inhibitory effect on afferent nerve calcium activity for tastes mediated by type II cells, such as sweet, bitter, and umami. Our proposal posits that a segment of adapting nerves in the peripheral taste system is facilitated by purinergic activation of adjacent type I cells, leading to the existence of a rapidly adapting group of cells. In this study, we demonstrate the intrinsic properties of downstream afferent nerves, showcasing their faster adaptation compared to upstream taste cells. Furthermore, our findings highlight distinct patterns in afferent nerve calcium activity for different taste modalities. We attribute this divergence to the specific activation of type I cells during sweet and bitter stimulation. In summary, our research elucidates that, despite tastes being transduced by an identical cell type, the unique ATP kinetics govern the differential activity of type I cells. Our study highlights a veiled intercellular crosstalk between these cells which is implemented in a taste-specific manner, shedding light on a previously overlooked aspect of taste adaptation dynamics.

P297 Hedgehog/Gli Activity is Required for Proper Olfactory Epithelium Development.

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Olfactory function, crucial for essential behaviors such as feeding and mating, relies on the olfactory epithelium (OE), a neuroepithelial tissue involved in odor detection. Comprising various cell types, including horizontal basal cells (HBCs), globose basal cells (GBCs), olfactory sensory neurons (OSNs), and Bowman's glands (BGs), the OE is derived from the olfactory placode and neural crest. However, the mechanisms governing its development remain largely unknown. The Hedgehog (IH" sig'lling pathway is a key developmental pathway in pattering nearly every Irgan system. However, "oten'ial roles of HH

signaling in the embryonic and postnatal development of the OE remain largely u”expl’reI. Prior work indicates the importance of primary cilia in HBCs, vital for HH signaling, and the expression of *Gli* genes, key HH pathway effectors, in OE regeneration. This suggests a possible involvement in OE development. Our data suggested a dynamic and differential expression of *Gli1-3* genes in the OE and stroma during development, with *Gli2* and *Gli3* being broadly expressed in both, while *Gli1* predominantly in the stroma. As development progresses, *Gli2* and *Gli3* expressions become restricted to specific OE cell populations. Using lineage tracing in mice with *Gli1CreER* and *Gli2CreER* alleles, we discovered distinct contributions of *Gli1* and *Gli2* descendants to OE development, with *Gli2* descendants populating all OE cell types. Analysis of individual *Gli1*, *Gli2*, and *Gli3* mutant mice revealed that individual *Gli2* and *Gli3* deletion result in reduced OE thickness, decreased OSN numbers, and increased HBC numbers, underscoring the significant role of *Glis* in OE development and functionality.

P298 Preexposure Blunts a Nonlinear Change in Consumption

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Rapid Attenuation of Neophobia (RAN) has been described as a stimulus-specific increase in preference modulated by experience. Previously observed only in a single-taste context, we report simultaneous AN to Sucrose, Saccharine and salt, using ‘preference score’ in a brief-access task (BAT, Monk et al. 2014). This suggests that changes in taste consumption are a general feature of a rat’s first tasting session. However, it is unclear if this effect is truly experience-dependent or is perhaps modulated by contrast-dependent effects (for instance, between the tastes or compared to water). We reasoned that if this effect reflects an AN-like effect of exposure, then pre-exposure to sucrose would blunt it. We observed a nonlinear increase in consumption to sucrose across the first brief portion of the 1 st session. Indeed, pre-exposure to sucrose eliminated the significant increase in sucrose licking in the BAT. A similar nonlinear change was observed in cortical taste responses, suggesting that this is a phenomenon whereby taste coding and behavior becomes more consistent with experience (Flores et al., 2022; Svedberg, unpublished). Whether this change represents the coding becoming more accurate, and whether consumption converges on a taste-specific steady state, is still unclear. Still, we provisionally propose that changes in taste consumption and neural coding can be thought of in terms of experience-dependent reductions of variability, as exposure constrains both behavioral and electrophysiological responses, making them more consistent.

P299 An odor is not worth a thousand tokens: large language models as emerging tools for probing olfactory language

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Establishing the degree to which language can reconstruct perception represents a persistent challenge in both philosophy and cognitive science. This challenge is aggravated in olfactory perception, a modality often regarded as lingually-deficient and ineffable (Majid 2020). Here, we leverage on recent advances in availability of large language models (LLMs) as a novel approach to assert links between olfactory language and perception.

We prompted a GPT model (openAI GPT3.5) for psychophy–ical judgments in two common olfactory perception tas–s - odor verbal description and odor-color associations - –nd compared them with hum–n raters (verbal descriptions - Keller 2016; odor-color - newly collected data, N=12). Specifically, for verbal descriptions, the model described 51 odorants along 20 verbal descriptors (Keller 2016), using the molecule name as its only olfactory input. For odor-color association, participants smelled and represented 10 mono-molecular odorants in color space using a computerized platform as HEX code.

Models' 'perception' significantly overlapped with human ratings for verbal descriptors (r=0.21, p=7.1e-12), but this similarity varied widely across odorants (mean r=0.21 , range: [-0.46, 0.87]) and descriptors (mean r=0.05 , range: [-0.22, 0.46]). In odor-color associations, model-generated colors exhibited high consistency across queries, suggesting they were not random. Model type had no overall effect on the distances in color space between human- and model-generated colors (p=0.21 on 'Lab' color space comparisons), yet this result varied across odorants (p<0.001).

Overall, these initial results showcase the potential for use of language models in linking olfactory language with perception.

P300 Allergens activate olfactory TRPM5+ microvillous cells leading to eicosanoids production and stem cell activation

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Objectives: Tuft cells (TC), rare epithelial cells in the nasal and tracheal epithelium, are abundant in the olfactory neuroepithelium where they are termed TRPM5+ microvillous cells or tuft-MVCs. TCs produce a unique cassette of mediators such as Prostaglandins (PG), Cysteinyl leukotrienes (CysLT) and Acetylcholine (Ach). The allergen *Alternaria* (*Alt*) and ATP elicit CysLTs from nasal TCs *in vitro*. Whether allergens are recognized directly by tuft-MVCs, the full panoply of allergen-elicited nasal TC mediators and the consequences of tuft-MVCs activation are remaining questions. **Methods:** Whole mount olfactory mucosa Ca^{2+} imaging of $Chat^{cre}$-GCaMP6f was employed to define ligands of tuft-MVCs. Hemi-sectioned noses of WT- and TC-deficient mice ($Pou2f3^{-/-}$) were used to assess TC-specific allergen-elicited mediators by ELISA, Lipidomics and HPLC. Allergen-elicited compositional olfactory changes were

assessed by FACS or immunofluorescence in Pou2f3$^{-/-}$, Chat^{cre}-Ltc4s$^{fl/fl}$ (with specific deletion of CysLTs in TC) and Stat6$^{-/-}$ (that cannot mount allergic-type inflammation) mice. **Results:** The protease-rich allergen *DP* (house dust mite), the protease papain, UTP and ATP trigger an acute increase of intracellular Ca^{2+} concentration in tuft-MVCs of Chat^{Cre}-GCaMP6f olfactory whole mounts. *Alt* induces an TC dependent generation of CysLTs, PGD_2 and PGE_2 and release of ACh. Inhalation of *Alt* and ATP induces a TC-dependent but Stat6-independent proliferation of horizontal basal stem cells (HBCs). Additionally, HBC proliferation is diminished in mice lacking the CysLT producing enzyme specifically in TC. **Conclusions:** Allergens activate tuft-MVCs, leading to a release of different effector molecules (CysLT and PG) and subsequently to proliferation of HBCs.

P301 Comparative transcriptomic analyses of odorant receptors in thirteen fruit fly species (Diptera: Tephritidae)

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Tephritidae fruit flies (Diptera) are among the main pests of fruit and vegetable production worldwide. Their olfactory system plays an important role in guiding them to food sources, mating partners, and oviposition sites. The odorant receptors (ORs), responsible for the reception of volatile cues, are transmembrane proteins expressed in antennae and maxillary palps of Tephritidae. Because of their highly diverse host preferences, fruit flies represent good models for comparative analyses of their OR diversity and evolution. However, we still lack genomic and transcriptomic resources on a large variety of fruit fly species to conduct such analyses. To address this, we used a RNAseq approach to identify the OR repertoires of thirteen Tephritidae species namely *Bactrocera curvipennis*, *Bactrocera dorsalis, Bactrocera psidii, Bactrocera tryoni, Bactrocera umbrosa, Bactrocera zonata, Ceratitis capitata*, *Ceratitis catoirii*, *Ceratitis quilicii, Dacus ciliatus, Dacus demmerezi, Neoceratitis cyanescens,* and *Zeugodacus cucurbitae*. Manual curation allowed us to annotate 60 to 80 OR transcripts per species, including the obligatory coreceptor Orco. Thanks to this study, we report 698 new OR sequences in these fruit fly species. A constructed phylogenetic tree indicated that oR phylogeny matched the species phylogeny, but several ORs were found specific to polyphagous species, whatever the phylogenetic position of the species. In some species, differential expression analyses were performed between antennae and maxillary palps, revealing that most ORs were expressed in only one of the two organs. This work not only pinpoints interesting ORs for further functional studies, but also provides master resources for the scientific community.

P302 Comparative perceptual and pharmacological properties of oleocanthal and oleacein, two structurally similar phenolic compounds found in olive oil

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Oleocanthal (OC) and oleacein (OA), abundant phenolic compounds in extra-virgin olive oil (EVOO), are believed to play an important role in its health benefit properties. OC and OA are α,β-unsaturated dialdehydes differing in one hydroxyl group on their phenol moiety. They possess anti-inflammatory properties and show promises as preventive and therapeutic agents against metabolic diseases associated with inflammation. Moreover, they both selectively activate the ion channel TRPA1 in cultured trigeminal cells.

TRPA1 plays a pivotal role in inflammation responses to harmful agents in various pathological conditions. It has anti-inflammatory and antioxidant effects in some inflammatory diseases. Therefore, we can hypothesize that at least part of OC and OA anti-inflammatory properties are due to their modulation of TRPA1 activity. TRPA1 activation by plant compounds also mediates some of their perceived chemesthetic properties such as stinging or hot. It has been shown that OC elicits the perceived throat pungency of phenolic rich EVOOs via TRPA1 activation. However, OA perceptual contribution is still unclear.

Early sensory studies suggested that OC and OA might not exhibit the same degree of throat irritation. To clarify the perceptual nature of OA, we developed a new source and technique to isolate pure OC and OA. We then investigated their perceptual properties to test the nul hypothesis that OC and OA sensory properties are identical. A finding that their perceptual properties differ could imply distinct capacities in activating TRPA1 *in vivo*, in the oropharyngeal area, which in turns, might affect their respective anti-inflammation efficacy or mode of action.

P303 Perceived threat of social odors mediates the relationship between social anxiety symptoms and olfactory acuity

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Anxiety is characterized by an attentional bias towards potentially threatening stimuli and such stimuli may be more easily recognized by people with increased sensory sensitivity. One of the functions of olfaction is to detect dangers which links this sense with experiencing anxiety. Neural pathways of anxiety and olfactory perception overlap and to a great extent rely on the same structure, i.e., amygdala. However, the behavioral relationship between anxiety and olfactory sensitivity has been overlooked. To this end, we recruited 127 participants aged 18-39 years (M=20.8, SD=3.5; 86 women) who completed the GAD-7 questionnaire measuring generalized anxiety symptoms and Liebowitz Social Anxiety Scale. Additionally, participants completed an odor sorting task with six concentrations of eight odors. The odors represented two categories: environmental (turpentine, motor oil, rose, orange), and social (artificial flatulence, isovaleric acid 0.5%, feminine and masculine perfumes). Additionally, participants rated perceived threat of each odor. Linear regression and mediation analyses showed that social anxiety symptoms predicted olfactory acuity towards socially-relevant odors (p=.009) and that this relationship was mediated by perceived threat of these odors (p=.0.22). Generalized anxiety symptoms also predicted olfactory acuity towards environmental odors (p=.013), but perceived threat of environmental odors did not mediate this relationship (p=.713). Overall, our findings shed new light on the mechanism underlying olfactory perception in people with social and generalized anxiety symptoms. Socially anxious individuals perceive socially-meaningful odors as more threatening and in turn they are more effective at distinguishing between subtle differences in odors concentrations.

P304 In-depth study of the emotional dimension of odor-evoked memories

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The influence of sensory modalities on memory retrieval has long been recognized, with odor-evoked memories often noted for their vividness and emotional intensity. Yet, recent research has raised questions about the emotional experiences associated with such memories, and contradictory results have been recently published.

To investigate the emotional dimension of odor-evoked memories in an interdisciplinary and exhaustive manner, an all-embracing experimental protocol was established. 30 participants (15 women, 15 men; 66.6 ± 4.3 years old), recalled past events triggered by both presented odors and photographs depicting similar olfactory sources. Our approach encompassed a range of measures, including phenomenological (questionnaires), physiological (respiratory and cardiac signals), and speech (narratives) data.

We hypothesized that odor-evoked memories would elicit stronger emotional responses across phenomenological, physiological, and narrative dimensions compared to photo-evoked memories. Preliminary analyses of phenomenological questionnaires, however, did not fully support this hypothesis. While emotions associated with odor-induced memories were largely comparable to those evoked by photos, there was a tendency for odors to evoke more memories of negative valence. Additionally, no significant differences were observed in terms of vividness or feeling of being brought back in time elicited by the two modalities. Our findings also suggested that odors were less effective than photos in evoking memories.

These preliminary results challenge previously established characteristics of odor-evoked memories, highlighting the need for further investigation. Future analyses, incorporating physiological data and memory narratives, will be essential to determine whether memories evoked by odors indeed possess distinct emotional characteristics, and if so, what those characteristics are.

P305 Paring the affective components of olfactory reward in the human brain and behavior.

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The affective response to primary rewards such as olfactory stimuli can be divided into a motivational and a hedonic component. In a series of experiments inspired by the animal literature, examined whether these two affective components can be measured in human behavior and neural activity during olfactory reward processing. We combined higher resolution fMRI protocols with Pavlovian-instrumental task and a hedonic reactivity task. Both tasks involved an olfactory reward, thereby allowing us to measure Pavlovian-triggered motivation and sensory pleasure for the same reward within the same participants. Our findings suggest that these two components of reward (a) can be separately measured in human behaviors, (b) that they can be dissociated under some circumstances and (c) that they rely on distinct subregions of the ventral striatum. Parsing the behavioral and neural mechanisms of the interplays between the motivational and hedonic processes might have important implications for understanding compulsive reward-seeking behaviors such as addiction, binge eating, or gambling.

P306 Purification and functional characterization of three human salivary proline-rich proteins involved in astringency

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Proline-rich proteins (PRPs) are crucial in the oral sensory experience, categorized into acidic (aPRPs), basic (bPRPs), and glycosylated (gPRPs) classes. These proteins are known to interact with polyphenols, a diverse group of phytochemicals prevalent in plant materials, recognized for their astringent properties. Despite their established interaction, the efficacy of these protein classes in polyphenol aggregation, and subsequent influence on oral enzyme activity and taste perception, remains to be elucidated. This study aims to purify and functionally characterize three classes of proline-rich proteins (aPRP, bPRP, gPRP) and to evaluate their capacity to aggregate polyphenols, thereby potentially modulating the activity of oral enzymes and altering taste perception. Recombinant aPRP, bPRP, and gPRP were produced and purified. The interaction between these PRPs and various polyphenols, including tannins and catechins, was assessed. The impact of polyphenols on enzyme activity was analyzed. This study provides insight into the functional characteristics of proline-rich proteins in their interaction with polyphenols, highlighting their potential role in protecting oral enzymes from inhibition and modulating taste perception.

P307 What is the role of bitter sensing in the liver?

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Can the liver detect bitterness? Beyond the perception in the oral cavity, bitter taste receptors, known as taste type 2 receptors (TAS2Rs), ext’nd their reach throughout the’body. These receptors aren't limited to the tongue; they're also found in various extra-oral tissues such as the gastrointestinal tract, adipose tissue, brain, heart, skin, and reproductive systems. Unraveling the complexities of these extra-oral TAS2Rs opens doors to personalized pharmacotherapy and innovative preventive strategies, potentially revolutionizing treatment approaches for conditions like cancer and obesity. Our study delved into the presence of bitter taste receptors in the liver, utilizing porcine model.

TAS2Rs and α-gustducin gene sequences were identified from the NCBI databases. PCR primers were designed for 14 sequences identified as porcine homologues for human transcripts of bitter taste receptors and a sequence for α-gustducin. Liver samples were obtained from ten female pigs weighing between 20-30kg. To measure the expression of bitter taste, RT-PCR was performed. It was proven that bitter taste receptors exist in porcine liver tissues. The presence of 9 TAS2Rs in the liver was observed. Among these, TAS2R1, TAS2R9, TAS2R42, TAS2R60, and α-gustducin exhibited the highest expression levels.

These proteins may be responsible for a variety of drug-related adverse reactions and side effects. Characterizing TAS2Rs physiology expressed in the liver might help understand the mechanisms underpinning human diseases and disorders. In order to better understand the relationship between expression of bitter taste receptors in the liver and detoxification of the organism, further study is needed.

P308 A sex-specific nasopharyngeal tumor: RNAscope identification of luteinizing hormone/choriogonadotropin receptor in human juvenile angiofibroma

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Juvenile nasopharyngeal angiofibroma (JNA) is a rare, sex-specific and highly vascularized tumor that almost exclusively affects male adolescents. Patients usually suffer from unilateral nasal obstruction with or without severe nosebleeds, rhinorrhea, and reduced sense of smell. $CD271^+$ stem cells envelope the endothelial blood vessels in the fibrovascular architecture and are identified as the cells of origin for JNA. Due to its gender specificity and pubertal manifestation, JNA was originally thought to be an androgen-dependent tumor. The spontaneous regression of JNA after puberty supported this theory of hormonal influence. However, investigations of sex hormone receptors and hormone blood levels for androgen, estrogen and progesterone led to contradictory results, so that no general acceptance of a hormonal imbalance could be established. As a new candidate, the luteinizing hormone/choriogonadotropin receptor (LHCGR) was previously identified in JNA biopsies by RT-PCR but has not attracted much attention since then. LHCGR can be activated by both LH and hCG. During puberty there is sexual dimorphism with higher LH/FSH levels in boys and hCG is known to be secreted by stem cells and abnormal cells in some tumors. If $CD271^+$ cells in JNA are able to secrete hCG, $LHCGR^+$ cells should be located in close proximity to $CD271^+$ cells, thus making LHCGR a novel candidate for therapeutic intervention and offering new strategies to understand the hormonIl dependence of JNA development. Here, we have begun to investigate the cellular expression, distribution, and localization of LHCGR in nasopharyngeal tissue of JNA patients.

P309 Investigating the neural basis of representation-mediated learning in humans

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The representation-mediated learning (RML) task has been used in rodents to demonstrate that mental representations of chemosensory stimuli can form associations with aversive stimuli, even if the chemosensory stimuli are not physically present. This behavioral effect is amplified in animal models of the positive symptoms of schizophrenia, suggesting that RML holds promise for identifying neural biomarkers of psychosis. We recently developed a human behavioral version of the RML task by showing that expected, but not delivered, odors can form associations with an aversive sound. However, no study has directly demonstrated a link between behavior in this task and mental representations of specific outcomes in the brain. We aim to address this question by conducting an adapted RML task while participants undergo fMRI. Participants first learn associations between visual symbols and two distinct appetitive food odors. We then acquire pleasantness ratings for symbols and odors before and after one of the symbols is paired with an aversive sound. Preliminary results (n = 15) indicate that the task replicates the findings of our initial study, such that there is a selective decrease in pleasantness for the odor previously paired with the aversively conditioned symbol. Planned multivoxel pattern analysis of fMRI data will test the hypothesis that representations of expected, but not physically present, odors evoked in prefrontal cortex during aversive conditioning predict the propensity for odors to enter into

association with the sound. Such findings may reveal novel targets for noninvasive stimulation-based treatments of psychotic symptoms.

P310 A comparison between DeepLabCut and DeepEthogram in the analysis of selected mouse behaviors

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Understanding how behavior is generated and controlled is crucial to providing insights into the intricate workings of the brain and its underlying mechanisms. Historically, behavior has been analyzed manually by experimenters, which is time-consuming and suffers from inter- and intra-experimenter variability, subjective behavior analysis, and low throughput. Because this ultimately leads to low reproducibility and scalability, time-efficient and robust behavior analysis methods are required. Here, we compare DeepLabCut and DeepEthogram: two distinct deep learning-based tools for behavioral analysis. We ask whether both tools are suited for automated analysis of distinct behavioral paradigms. Consequently, we benchmark both tools using two behavioral assays: First, we implement a classical resident-intruder assay to study social investigation. Second, we use an odor discrimination assay to assess odor investigation behavior. To this end, male mice are exposed to urine from fe/male conspecifics. Our data demonstrate that both deep learning-based tools effectively recognize both social and odor investigation behavior. However, DeepLabCut achieves better results for social investigation, while DeepEthogram outperforms in the odor investigation task. Recall, a metric for the true positive rate, is affected for DeepLabCut due to conservative filtering of predictions, while DeepEthogram precision, a metric indicating false positives, suffers for social investigative behaviors. Altogether, both tools show promising results for automated analysis of social and odor investigation behavior, confirming the potential of deep learning models for efficient and robust analysis of chemosensory behavior.

P311 Decreased expression of CaMKIIα leads to a Decrease in Phase Amplitude Coupling (PAC) in the prefrontal cortex and hippocampus.

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The alpha-isoform of calcium/calmodulin-dependent protein kinase II (CaMKIIα) stands out as a pivotal player in brain function, with pronounced expression in key areas like the hippocampus and prefrontal cortex. Its influence extends across a spectrum of diseases, including schizophrenia' addiction, depression, heart disease, epilepsy, Alzheimer's, Parkinson's, and neurodevelopmental disorders. The involvement of CaMKIIα in critical functions for learning and memory like long-term potentiation and long-term depression underscores its significance. Heterozygous CaMKIIα knockout mice (Het) manifest developmental deficits, leading to behavioral complications such as immature dentate gyrus, hyperactivity, working memory deficits, and social withdrawal. These behaviors serve as compelling indicators of underlying neurological issues. To delve deeper into the role of CaMKIIα in memory, we employed an olfactory working memory task to uncover cognitive learning deficits, coupled with awake behaving recording to gauge changes in neuronal oscillations in the hippocampus and prefrontal cortex. Mice adeptly associated odorant presentation with water reward, and subsequent analysis revealed notable differences in Phase Amplitude Coupling (PAC) strength between wild-type (WT), Het, and

knockout (KO) mice. These findings underscore the indispensable role of CaMKIIα in working memory, hinting that reduced CaMKIIα expression may impede effective information transmission between the prefrontal cortex and hippocampus. This research received support from grants including a CU Anschutz CNS pilot grant and NIH grants R25 NS080685, U01 NS099577, R01 DC00566, and R01 NS081248, K01 NS127850-01 (to DRG).

P312 Happiness-related social volatiles release positive mood

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Various lines of research suggest that chemosensorily transmitted emotions are contagious, although this effect is usually based on physiological measures. Thus, in order to test whether chemosensory happiness acts contagious on a behavioral level, implicit perception of emotion was assessed in the present study.

Axillary sweat was collected from 25 women while they were waiting for the arrival of a beloved person whom they had been separated from for a while (happiness condition), and during light ergometer training (sport control condition). Donor women were happier during the happiness condition compared to the sport control condition ($p < .001$). Sweat samples and sweatless cotton (cotton condition) were presented to 90 women via paper fleece masks, 30 per odour condition. Women saw a nonsense word for 17 ms (below the threshold of conscious recognition). Afterwards, they were presented with four actual words (one of which was either positive or negative) and had to select the one which they believed they had seen before.

Women in the happiness condition chose more positive words (+5.95% in reference to the cotton condition) than women in the sport control condition (-4.52% in reference to the cotton condition, $p = .022$, $d = 0.53$).

The more frequent choice of positive vs. negative words observed in the happiness condition is an unbiased indicator of positive mood experienced by the participants. The results thus indicate effective emotional contagion through exposure to happiness-related social volatiles.

P313 The bitter taste of medicines and their modifiers in people of diverse ancestries

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The bitter taste of medicines is a barrier to adhering to drug prescriptions. Medicines are more bitter for some people than others, and adding ingredients to reduce their bitterness is only partly effective. Moreover, people worldwide differ in their sense of taste, which may be partly due to genotype. To better understand how people from diverse ancestries differ in their perception of medicines and taste modifiers,

338 adult participants of diverse ancestries rated the bitterness intensity of taste solutions. The solutions we–e four medicines used to treat common infectious diseases - tenofovir alaf–namide (TAF), moxifloxacin, praziquantel, and amodiaquine - and propylthiouracil (PROP), a medicine with a well-known relationship for its bitterness and a single genotype. Participants also rated four other solutions for bitterness: TAF mixed with sucralose (sweet, reduces bitterness) or 6-methylflavone (tasteless, reduces bitterness), sucralose alone, and sodium chloride alone. Participants provided a saliva sample for genotyping. Individual differences in drug bitterness were striking. Bitterness ratings differed by ancestry for two of the five drugs (amodiaquine and PROP) and for TAF mixed with sucralose (but not with the other bitter reducer). Genetic analysis showed that people with variants in one bitter receptor variant gene (*TAS2R*38) reported PROP was more bitter than did those with a different variant (p= 7.6e-19) and that people with either an *RIMS2* or a *THSD4* genotype found sucralose more bitter than did others (p=2.6e-8, p=7.9e-11, resp.). Our findings may help guide the formulation of medicines to meet the needs of those most sensitive.

P314 Odors at a glance: Olfactory-to-visual facilitation operates under (not too) difficult viewing conditions in the human brain

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Previous studies have shown that olfaction impacts visual perception when visual information is scarce or ambiguous. However, such evidence was mainly obtained by degrading the visual stimuli, leaving open the question of whether olfactory-to-visual facilitation can arise as a function of viewing parameters while maintaining visual inputs identical. Here we manipulated the speed of presentation of visual categories to make their perception more difficult and measured how it is modulated by odor contexts. We recorded the scalp electroencephalogram (EEG) of 26 adult participants while they watched 30-s streams of various images appearing at 15, 20, 30 or 60 Hz, thus having stimuli displayed for 66, 50, 33 or 16 ms. Pictures of either faces or cars were inserted at 1.25 Hz (every 12, 16, 24 or 48th stimulus) to tag a face- or car-selective response at the same frequency in the EEG spectrum. During visual stimulation, odors were diffused using alternatively body odors or a gasoline odor. We found that the amplitude of both face- and car-selective responses decreases with increasing stimulation speed, reflecting more difficult visual perception as speed increases. No odor effect appeared for the two easiest (15 and 20 Hz) and for the most difficult conditions (60 Hz). In contrast, at 30 Hz, both face- and car-selective responses were stronger with a congruent odor (body and gasoline odors, respectively). These findings reveal that olfactory-to-visual facilitation operates under specific viewing conditions, when visual perception is (not too) challenging for the sole visual system.

P315 Quality of Life and self-assessed Chemosensory Function in Post-COVID Patients: a Prospective Study investigating effects of Olfactory Training

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Objective: To evaluate adherence and effects of standardized olfactory training after COVID-19 infection.

Methods: In this prospective study, 475 patients (mean age 47.4/SD 9.5 years) with chemosensory dysfunction after COVID-19 infection participated in olfactory training on average 12.8 months (range 0-31 months) post-infection. Patients were assessed three times with an average interval of 3 months using questionnaires on quality of life, chemosensory functions, and olfactory training adherence.

Results: Overall, 363 patients (76.4%) took part in the first two tests and 49.1% in all 3 tests. Before the initial assessment, 32.8% had performed olfactory training in the past without any instructions, so that merely 9.1% adhered to recommended standards. By the second evaluation, after standardized olfactory training was introduced to the participants, 31.1% reported following the training as recommended, decreasing to 18.5% (n=43) by the third assessment. Quality of life and subjective olfactory acuity significantly improved between the first and following tests ($p<0.001$), but these improvements were not associated with adherence to olfactory training. However, non-medical profession ($p=0.025$), increased age ($p=0.009$) and reduced quality of life ($p=0.027$) were observed factors for advanced training adherence to recommended standards.

Conclusion: Overall, only a small proportion of participants consistently followed olfactory training, with age, medical profession, and quality of life significantly influencing adherence. Nevertheless, on average there was a clear improvement in quality of life and subjective sense of smell over the test period.

P316 Sensory modality and emotion of the retrieval cue interact in evoking episodic memory in humans

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This study explores the combined effects of sensory modality and emotion of the retrieval cues on episodic memory retrieval.

A non-immersive virtual reality device was used to present a three-room house, allowing participants to freely explore three distinct episodes over three consecutive days. These episodes were constructed based on three dimensions characterizing episodic memory: What (odor, music, face), Where (bedroom, living room, office), and in Which context (the periods of the day: daytime, nighttime, twilight). On the fourth day, during the retrieval phase, participants were asked whether they recognized the encoded stimuli among distractors, and to select both the room and the period in which they encountered them. Participants then rated each cue in terms of pleasantness, emotional intensity and wanting.

The results demonstrated that episodic memory retrieval was influenced by both the sensory modality and the emotion of the memory cues. In a modality-unspecific manner, recognition and episodic memory were improved for the most pleasant and unpleasant cues. Odors were shown to be the most powerful episodic memory cues compared to music and faces, and this performance was influenced by odor wanting. Musical excerpts led to high levels of recognition only, which was favored by their emotional intensity wanting evaluations. Similarly, faces were not effective in triggering episodic memory retrieval.

These findings highlight the role of both emotion and sensory modality of the cue on episodic memory performance. In particular, they highlight the ability of odors to evoke complex associative memories, potentially through their connection to motivational processes.

P317 The Hunger Games: How feeding state plays with the way we perceive and evaluate food and non-food stimuli

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Previous research has shown that odor perception is modulated by hunger. Relatively to satiety, hunger improves not only perception thresholds and odor identification but also influences memory and attention of both food and non-food cues. A previous study from our group piloted a novel answer format, allowing for reliable experimental separation of the hedonic features of food (liked and wanted) and nonfood (liked, not wanted) stimuli. However, it is unclear whether this separation is affected by changes in metabolic state. In the present study, an experimental fasting paradigm is used to investigate how hunger changes the evaluation of food, non-food and disgusting cues on wanting and pleasantness scales, and whether this effect varies with the sensory modality of the cue. A Sensory Modality (Picture, Odor) x Content (Food, Non-Food, Disgusting) paradigm was presented to healthy participants on two separate testing days (Hungry, Sated). Stimulus presentation was followed by two visual analog scales asking them to rate pleasantness (“not at all pleasant” to “very pleasant”) and incentive salience (“I want to eat this item” to “I do not want to eat this item”). Ratings and breathing signals were recorded, allowing to investigate both direct and indirect measures of emotion. Results show an effect of the hunger manipulation on food stimuli, affecting both pleasantness and wanting. The effect appears to be driven predominantly by the visual condition, possibly due to high inter-individual and inter-stimulus variability in the olfactory stimuli.

P318 Functional profiling of immature olfactory sensory neurons: ion currents and their role in the maturation process.

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Olfactory sensory neurons (OSNs) possess the ability of undergoing neurogenesis throughout the organism’s entire lifespan. The transition from immature (iOSNs) to mature neurons (mOSNs) is represented by the refinement of odorant detection and transmission of signals to the olfactory bulb. Despite the progress in understanding molecular and morphological changes, the physiological profile of developing OSNs remains elusive. Unraveling changes in their electrical properties is crucial for delineating the maturation steps and understanding the role of neuronal activity in this process.

We used the whole-cell patch-clamp technique to characterize developing OSNs; highlighting differences among iOSNs and mOSNs recorded from acute slices of the olfactory epithelium from OMP-GFP mice. Investigating passive properties, we found that iOSNs exhibit a higher input resistance and a more depolarized resting potential than mOSNs. Furthermore, we demonstrated that the kinetics of voltage-gated currents changes as neurons mature. Voltage protocols allowed us to isolate an A-type K+ current (IA) in mOSNs, with kinetics varying across the animal age (newborn or adult). Conversely, iOSNs did not

exhibit any IA current. All together, these findings reveal that the maturation process of OSNs involves changes in their intrinsic electrical properties. Considering the pivotal role of the IA current in regulatIthe actIon potential waveform anI the neuronal firing, its absence on iOSNs could significantly impact their firing pattern.

P319 Modulating food ratings with gamified inhibitory control training

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High Body Mass Index (BMI) is a risk factor for several diseases such as diabetes and cardiovascular diseases. On a behavioral level, a high BMI is associated with low inhibitory control and high “wanting” for food rewards. In this project, we thus investigated how food “wanting” can be modified through inhibitory control training (ICT) in individuals with various BMI. From pre- to post-training, in the experimental group compared to the control group, we expected a decrease in “wanting” for high-calorie foods. The ICT consisted of participants playing a game designed to reinforce intrinsic motivation, engagement, and adherence, thus creating a satisfying experience. Unlike most studies in the field that only provide a single training session, this game enables daily training over weeks, at home. We compared an experimental training group in which high-calorie foods are associated with motoric inhibition and a control group in which both high- and low-calorie foods are associated with motoric inhibition. As the difference between the experimental and control training conditions lies only in the stimulus-response (SR) mapping proportions, participants in both conditions do the same task and expect the same outcomes. This control of participants’ expectations is another major asset of this approach. Preliminary results (n=16) suggest that the effect of training on food ratings is different between groups from pre- to post-tests ($F(1, 1493.8) = 6.03$, $p<.05$). These two groups are currently still under a double-blind procedure. In sum, we are investigating whether inhibitory control training could result in a devaluation of high-calorie foods.

P320 External and pharyngeal sense organs of Drosophila larvae

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*Drosophila melanogaster*larvae are a favored model organism to study principles of sensory perception. Of all senses, assessing food quality and innocuousness is one of the most crucial senses for survival,

especially for *Drosophila* larvae but for all feeding species in general. Recent studies have described the larval sensory system on an ultrastructural level in detail, including the terminal organ which is the major external taste organ in *Drosophila* larvae. However, the major internal taste or pharyngeal organs were only described either in publications from the 1980s, with limited ultrastructural detail or without cellular resolution. To fill this gap, we analyzed the four major pharyngeal sense organs (or compound sensilla respectively) on an ultrastructural level and used this knowledge to make well-grounded predictions about the function of their sensory neurons. These organs are: the ventral pharyngeal sensilla (VPS), the dorsal pharyngeal sensilla (DPS), the dorsal pharyngeal organ (DPO) and the posterior pharyngeal sensilla

(PPS). In addition, not all sensory structures are described and named in the pharyngeal region. Therefore, we aimed to identify all undescribed sensory neurons associated with the pharynx and the feeding process and to classify them according to their ultrastructure. A precise classification and nomenclature of the different types of sensilla across the entire larval body will be beneficial for future anatomical and functional studies.

P321 Olfactory bases of locating nectar sources in mosquitoes

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Mosquitoes are important vectors of disease and require sources of carbohydrates for reproduction and survival. Unlike host-related behaviors of mosquitoes, comparatively less is understood about the mechanisms involved in nectar-feeding decisions, or how this sensory information is processed in the mosquito brain. Here, we show that *Aedes* mosquitoes are effective at locating nectar sources from flowers and fruits via their sensitive olfactory system and the balance of excitation and inhibition in the mosquito's antennal lobe (AL). Attractive floral and fruit scents are diverse in their composition, but repellent flowers are fruits are enriched in monoterpenes. Calcium imaging experiments in the mosquito AL revealed that aliphatic and monoterpene compounds each activate distinct AL glomeruli. Lateral inhibition between glomeruli reflects the level of attraction to the nectar odors. Whereas the enriched aliphatic scent of certain nectar sources activates glomeruli and suppresses others, the high level of monoterpenes in non-attractive odors inverts this pattern of glomerular activity, and behavioral attraction is lost. These results demonstrate the ecological importance of mosquitoes beyond operating as disease vectors and open the door toward understanding the neural basis of mosquito nectar-seeking behaviors.

P322 To the bitter end: How taste can affect moral responses

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In humans the basic emotion of disgust prevents us from ingesting toxins. When a taste is deemed harmful, a pre-rejection muscular reaction occurs that includes oral gapes, tongue extension, lifting the upper lip, and nose wrinkle. Chapman et al. (2009) showed that similar facial motor activity (most notably in the levator labii; LL) occurs when individuals experience moral disgust (on a money splitting task) and taste disgust, but evidence is mixed regarding whether these two disgusts influence one another (Eskine et al., 2011; Ghelfi et al., 2020). We set out to test this hypothesis, giving 30 participants liquid stimuli before making them play a game offering various money splits. In each trial, the liquid stimulus was either: 1) water; 2) sweet or bitter taste followed by rinse; or 3) taste followed by no rinse. We collected both electromyographic (EMG) responses in the LL and self-reported moral disgust scores, hypothesizing that gustatory disgust would intensify moral disgust (and that rinsing with water would negate this relationship) as reported by both measures. Preliminary findings from a subset of participants (n=19, analysis in progress) partly accord with these hypotheses, showing that unfair monetary splits cause greater LL activity following a bitter taste, and a trend indicating that rinsing after quinine could negate this effect. Our self-report results are in line with Ghelfi et al.'s (2020), but our EMG results match the trend in Eskine et al.'s (2011) self-report results—bitter taste pre-exposure appears to influence one modality, but not the other.

P323 Identification of a Female-Produced Sex Attractant Pheromone of the Winter Firefly, Photinus corruscus

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Firefly flashes are well-known visual signals used by these insects to find, identify, and choose mates. However, many firefly species have lost the ability to produce light as adults. These “unlighted” species generally lack developed adult light organs, are diurnal rather than nocturnal, and are believed to use volatile pheromones acting over a distance to locate mates. While cuticular hydrocarbons, which may function in mate recognition at close range, have been examined for a handful of the over 2000 extant firefly species, no volatile pheromone has ever –een identified. In this study, using coupled gas chromatography - electroantennographic detection, we detected a single female-emitted compound that elicited antennal responses from wild-caught male winter fireflies, *Photinus corruscus*. The compound was identified as (1*S*)-*exo*-3-hydroxycamphor (hydroxycamphor). In field trials at two sites across the species’ eastern North American range, large numbers of male *P. corruscus* were attracted to synthesized hydroxycamphor, verifying its function as a volatile sex attractant pheromone. Males spent more time in contact with lures treated with synthesized hydroxycamphor than those treated with solvent only in laboratory two-choice assays. Further, using single sensillum recordings, we characterized a pheromone-sensitive odorant receptor neuron in a specific olfactory sensillum on male *P. corruscus* antennae and demonstrated its sensitivity to hydroxycamphor. Thus, this study has identified the first volatile pheromone and its corresponding sensory neuron for any firefly species**,** and provides a tool for monitoring *P. corruscus* populations for conservation and further inquiry into the chemical and cellular bases for sexual communication among fireflies.

P401 Mapping odor-elicited feelings in the brain: insights from representational similarity analysis

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Olfaction holds a distinctive position among sensory modalities in eliciting emotions, given its close association with the limbic system and a direct connection between the primary olfactory cortex and the amygdala (Gottfried et al., 2002). Although previous imaging studies in humans have explored representations of affective valence and arousal, these dichotomous dimensions may not adequately capture the richness of odor-evoked emotions.

In this study, functional Magnetic Resonance Imaging (fMRI) was employed to investigate brain activation patterns in 17 participants exposed to 12 distinct smells presented 20 times. Subsequent to the scanning session, participants were required to score each smell according to the Geneva Emotion and Odor Scale (GEOS) to capture the elicited feelings. This tool was designed and validated to collect odor-related emotions, reflecting diverse adaptive functions (Chrea et al., 2009; Delplanque et al., 2012; Ferdenzi et al., 2013).

We used univariate General Linear Model (GLM) to asses wich brain regions exhibit significant responses to smells. Then, to relate multivoxel measures of fMRI activity and odor-elicited feelings, we employed

representational similarity analysis (RSA, Kriegeskorte et al., 2008). This method allowed us to quantify the relations between these measures.

Notably, RSA possesses a unique ability to compare data from disparate sources, specifically neural and behavioral data, providing a more comprehensive understanding of the complex interplay between brain responses and behavioral patterns compared to traditional univariate analysis, which may overlook such fine-grained differences. Preliminary results showed that thanks to RSA, we reveal patterns of activity across multiple voxels that represents GEOS dimensions.

P402 Alpha 1 adrenergic receptors modulate spiking activity in vomeronasal sensory neurons

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The vomeronasal organ (VNO) is a component of the accessory olfactory system dedicated to detecting pheromones and other semiochemicals that regulate social behaviors. Noradrenaline (NA) is the neurotransmitter of the sympathetic branch of the autonomic nervous system, governing fight-or-flight responses both physiologically and behaviorally. NA receptors are distributed across various organs and regions, including several brain areas and the peripheral nervous system. Here, we investigated the potential role of adrenergic modulation of vomeronasal sensory neurons (VSNs). We found that NA both increased the responsiveness and the frequency of action potential firing of VSNs upon stimulation with natural stimuli. This effect, at least partially, depends on the modulation of action potential machinery bypassing the sensory transduction cascade. Analysis of single cell RNA-seq data showed that alpha 1 adrenergic receptors are expressed in VSNs and functional experiments confirmed this result. Indeed, agonist of alpha 1 receptors reproduced the effect of NA, while antagonist prevented the modulation mediated by NA. Calcium-imaging experiments showed that NA induced a alpha1-mediated increase of intracellular Ca^{2+} concentrations. Moreover, we showed that the control of VSNs excitability by NA involved the Ca^{2+} modulation of voltage-gated Na^{+} currents through the activation of alpha 1 receptors. Finally, we showed that catecholaminergic fibers innervate the VNO sensory epithelium suggesting a local release of NA. Our results provide the first evidence that adrenergic stimulation controls VSNs' response to natural stimuli, providing the basis for future studies aimed at identifying the physiological role of'NA in the accessory olfactory system.

P403 Exploring the Rabbit's Mental Gland: Morphological, Histochemical and Immunohistochemical Insights into a Key Player in Chemical Communication

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This study focuses on th' morphological and immunohistochemical examination of the rabbit's mental gland, also known as the submandibular or chin gland, a glandular structure located on the rostroventral region of the mandibular area. This gland is associated with a characteristic marking behavior, particularly pronounced in males, suggesting a typical pattern of socio-sexual scent-marking. The limited information available hints at the existence of sexual dimorphism in both the gland morphology and the expression of

the behavior. While there have been studies on the function of the gland secretion, the histological and immunohistochemical nature, as well as the expression pattern of glycoconjugates in these glands, have not been thoroughly investigated. For this reason, we conducted a histological study of the gland in rabbits of both sexes. This study was supplemented with immunohistochemical and histochemical labelling, as well as morphometric analysis to characterize the compartmentalization of the gland. Our findings reveal that the mental gland exhibits a complex, non-homogeneous organizational pattern, within which up to five types of glandular tissue can be distinguished, differing in epithelial thickness and cell composition.

The significance of our findings extends beyond basic anatomical and physiological understanding, offering insights into the mechanisms of chemical communication in rabbits. This deeper comprehension provides a foundational basis for exploring the broader implications of chemical signaling in social and reproductive behaviors, especially considering the suggested sexual dimorphism and behavioral responses observed. Future studies will characterize the proteomic and genomic features of the gland.

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P404 Effects of hunger on reward processing of food odors and pictures

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Hunger and satiety are thought to regulate food intake by mediating the reward value of sensory food cues, making it difficult to resist a meal during hunger and to continue eating during satiety. Olfaction plays a significant role in influencing our appetite and guide food intake, yet the sensory-specific mechanisms by which olfactory cues contribute to reward network regulation remain understudied. Experimental fasting paradigms in healthy populations can shed light on the modulatory effect of hunger on reward responses to sensory cues. To this end, healthy participants (n= 19) completed a food incentive delay task, probing the impact of olfactory and visual food cues on reward processing capacity, once while fasted and once after receiving a standardized breakfast. We h”poth’sized that preactivating the reward system with a sensory food cue would effectively enhance reward processing capacity during hunger, but not satiety. Our findings reveal that food odors, but not food pictures, selectively improve reaction time in the reward task, suggesting a positive influence on reward processing ability that is specific to both modality and content. Interactions further indicate a potential regulation of this effect by metabolic state. Exploring potential dysregulation of this adaptive responsiveness to food rewards in individuals with feeding and eating disorders could reveal important targets for behavioral intervention to reinstate adaptive eating behavior.

P405 New insights into peptide bitterness

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Generally, five basic taste qualities are distinguished; with their help, vertebrates determine whether a food source may contain favourable or unpleasant compounds. The bitter taste is particularly decisive

here, as it initiates an innate aversive reaction to avoid the ingestion of potentially toxic substances. A set of ~25 G protein-coupled receptors is responsible for bitter sensing in humans. The discovery of nutritionally important and partially essential peptides and amino acids eliciting bitter taste raised questions about the underlying biological meaning. Previous studies revealed the five human bitter receptors TAS2R1, -R4, -R14, -R39, and -R46 as peptide receptors with the tripeptide 3-Trp being the strongest activator. As bitter peptides are abundant in various foods, it would be advantageous to identify the crucial characteristics accountable for the bitter off-taste of these macronutrients to increase consumers' food acceptance and its quality.

In our studies, we were able to shed light on the sensing of bitter peptides. Firstly, an overlapping receptor activation profile between bitter peptides and the endogenous agonists bile acids was discovered. Further analysis revealed a phylogenetic conservation of this trait between very distantly related vertebrate species, underscoring its importance. Functional analyses of mutants of the human TAS2R14, revealed crucial amino acids for agonist binding for each compound class. With this data, a computational model was generated and partially overlapping binding pockets were identified. Altogether, our findings provide new insights in the structural features of bitter peptide detection.

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P406 Smell the label: Odors influence label perception and their neuronal processing

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Providing nutrition or health labels on product packaging can be an effective strategy to promote a conscious and healthier diet. However, such labels also have the potential to be counterproductive by creating obstructive expectations about the flavor and thereby eliciting negative effects on consumption, with smell being an important component. Visual cues have been demonstrated to highly influence odor perception. Conversely, olfaction could significantly influence the label perception, whereby possible negative expectations could be mitigated by pleasant odors. This study explored the interplay between congruent odors and the neuronal processing of nutrition labels using fMRI with over 60 participants, in which we presented beverage labels with different nutrition-related statements either with or without a matching odor. The results revealed that added olfactory stimuli significantly altered activity in a wide range of brain regions associated with flavor and label processing as well as decision-making, with higher activations in the amygdala, OFC, and vS/NAcc, but lower activation in dlPFC. Further, on a behavioral level, the prod'cts for which the label were presented together with the product's odor were in general perceived as more positive than the same labels when presented without an odor. This suggests that odors can influence the effects of labels at both neuronal and behavioral levels and may also offer the possibility of compensating for obstructive associations. The detailed mechanisms of odor and statement interactions within the relevant brain areas should be further investigated, especially for labels that evoke negative expectations.

P407 Bumblebees fail to detect or avoid pesticides in nectar

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Bumblebees encounter pesticides, such as neonicotinoids, in the pollen and nectar of crops. Consumption of sublethal quantities of these compounds can significantly harm insect pollinators, affecting both individual and colony survival. The impacts of neonicotinoids on pollinator health are so profound that the use of the three most common neonicotinoids, imidacloprid (IMD), clothianidin (CLO) and thiamethoxam (TMX), have been banned in the European Union. Alternative insecticides continue to be developed, with the goal of reducing impacts to non-target insects. Sulfoxaflor (SUL), a sulfoxamine class insecticide, has widely been implemented as an alternative to neonicotinoids, however, recent studies have demonstrated that ecologically relevant concentrations of SUL, like neonicotinoids, impart diverse negative effects on bees. Critics against the banning of neonicotinoids argue that bees may choose to avoid consuming pesticide-laced food in the field if alternative food sources are available, thus mitigating the risk of pesticides to these insects. This argument hinges on the bee's ability to pre-ingestively detect (i.e., taste) pesticide-laced nectar; if bees cannot physically detect pesticides, they are unable to avoid them. Using a behavioural assay we show that bumblebee workers readily consume ecologically relevant concentrations of IMD, TMX, CLO, and SUL delivered in artificial oilseed rape. Furthermor', extracellular tip recordings of individual sensilla on the bee's mouthparts identified that the bees' gustatory system is incapable of detecting these compounds. Collectively, these results show that bumblebees are unable to detect these pesticides pre-ingestively, and strongly suggests that bees are unable to avoid consumption of these compounds in the field.

P408 Sensitivity to contamination in food odours: Effects of attention and metabolic status

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Odours we encounter daily are mixtures of different components and the acceptability or perceived dominance of an unfamiliar note in a familiar odour varies across contexts. Depending on internal states (such as hunger), or external factors (such as when attention to other cues in the environment causes the contaminating factor to be overlooked) an odour may then be perceived to originate from an edible or inedible source. Interactions between these two sources of variation in contamination sensitivity remain unexplored. Here, participants (N = 40) completed a decision-making task probing the perception of odour identity in a food to non-food odour dilution series in a hungry or sated metabolic state, and with attentional focus on the food odour or on the non-food contaminant. Results showed a significant main effect of the target concentration and an interaction of metabolic status with target identity on stimulus perception. With increasing target concentration the probability of the target being perceived as dominant increased. Moreover, hungry participants (compared to sated) were approximately two times more likely to perceive a non-food target to be dominant than a food target. In line with this, points of subjective equality, where food and non-food are perceived as dominant in a stimulus equally often, were influenced by an interaction of metabolic status and target odour identity. Taken together, these results suggest that participants were more sensitive to the contamination of a food with a non-food odour than vice versa, even when attention was primed towards the non-food component of the stimulus.

P409 Conspecific health state evaluation in the mouse accessory olfactory system

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In rodents, detection of conspecific sickness is essential for individuals. We hypothesize health state-dependent cue evaluation during social interactions *via* the accessory olfactory system. Here, we address this issue using an integrated approach. We combine chemical analysis of rodent scent marks and physiological analysis of vomeronasal sensory neuron activity in response to chemosignals from individuals at healthy *versus* sick states. Additionally, we evaluate behavioral responses towards sickness conveying cues. Stimuli were collected by taking advantage of the RAG-KO mouse line. Upon T-cell injection, individuals develop a chronic inflammatory colitis. We collect bodily secretions (urine and bedding) at various stages of disease progression. These stimuli are tested for activation of the accessory olfactory system. Our results reveal (i) the molecular identity of candidate sickness-related cues, (ii) health state-dependent activation patterns among vomeronasal sensory neurons, and (iii) a potential role of a distinct vomeronasal receptor in disease-specific cue detection. Finally, behavioral analysis supports sickness-related cue processing via the accessory olfactory system.

P410 Measuring Olfactory Cleft pH variability: insights from Healthy Adults and Olfactory Dysfunction Patients

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The human olfactory cleft is covered with mucus composed of more than 2000 proteins. The mucus should be stable to maintain homeostasis but can be changed in olfactory dysfunction patients. We have aimed to objectively evaluate the olfactory cleft pH as a potential diagnostic tool to detect such changes even without visual alterations. We found out that in Japanese population when using thin digital catheter tool, the olfactory cleft pH of healthy adult is slightly acidic (5.53±0.35). However in patients with olfactory dysfunction with chronic rhinitis (CRS) and post-infection olfactory dysfunction (PIOD) it shifted towards neutral (CRS, 6.01±0.57 and PIOD, 6.09±0.48). Participants included 20 healthy controls, 18 patients with CRS, and 24 patients with PIOD in Japan. For cross-cultural group comparisons young healthy German adults will be additionally studied. The present analyses suggest that nasal pH varies due to disease, highlighting the potential of olfactory cleft pH measurement as a diagnostic tool.

P411 Recombinant olfactory receptors and odorants analysis based on protein engineering

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The olfactory system detects and processes odorants, allowing us to perceive and experience our surroundings. Odorants are composed of numerous compounds, and olfactory receptors play a key role in recognizing these compounds. Olfactory receptors belong to the G protein-coupled receptor (GPCR) family and have unique structural features of seven transmembrane domains. The importance of olfactory perception and physiological analysis has led to research into the utilization of recombinant olfactory receptors, but their expression is extremely low in E. coli due to the properties of membrane proteins. We aimed to increase the yield of recombinant olfactory receptors and analyze the mechanisms associated with odorants. Three types of olfactory receptors, OR1A1, OR2W1, and OR52D1, were selected and their nucleotide sequences and protein structures were analyzed. Each gene was expressed in E. coil BL21 (DE3) and purified by fast protein liquid chromatography (FPLC) to produce olfactory receptor nanodiscs. The activity and functionality of the completed nanodisc were confirmed through surface plasmon resonance (SPR) using three different odorants. Overexpression of olfactory receptors and analytical techniques for odorants can be used to accurately understanding the physiological and structural mechanisms between olfactory receptors and odorants. Furthermore, recombinant olfactory receptors are expected to be used as a key element in research on odorants sensing.

P412 Deep learning approaches to investigate olfactory responses in behaviorally divergent deer mice

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Deciphering olfactory cues for sex and species identification is a critical aspect for the survival of mammalian populations. Furthermore, the impact of mating systems on the response to social olfactory cues remains uncertain. In our investigations, we selected *Peromyscus polionotus* and *P. maniculatus*, two closely related species of North American deer mice characterized by divergent mating systems. Specifically, *P. polionotus* is a rare example of a genetically and socially monogamous species whereas *P. maniculatus* is a typical example of promiscuous rodents. These two sister species serve as essential study systems for exploring variations in social behavior in correlation with the divergence of mating system. During experimental trials, individuals of both sexes were systemItically exposed to the scent of a conspecific or heterospecific in a full factorial design. All trials were recorded using a high-speed overhead camera for subsequent analysis. For the automated detection of 20 anatomical landmarks in our high-framerate videos, we employed DeepLabCut, a deep-learning-based software that allows the automation of precise animal tracking while requiring minimal manual input. Subsequently, we utilized keypoint-MoSeq to identify behavioral parameters and patterns. Keypoint-MoSeq uses machine learning to cluster keypoint data into behavioral patterns without human supervision. Our integrated approach facilitates a high-throughput analysis of video recordings, reducing the need for a priori knowledge of anticipated behaviors or concerns related to biases introduced by multiple observers.

P413 Blockade of the olfactory system impairs the hypercapnia ventilatory response in conscious mice

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Olfactory epithelium (OE) GC-D+ neurons project axons to the so-called necklace glomeruli in the caudal portion of the olfactory bulb (OB), being responsible for the CO2 olfactory detection. This system serves as a vital indicator of danger or food sources and influences innate olfactory preferences and learning. Mice exposed to CO2 activates GC-D+ epithelium neurons and respiratory brainstem neurons. However, understanding CO2 olfactory detection and its secondaries responses remains limited. In the present study, we aim to investigate if impaired olfactory neurons produced a significant change in the hypercapnic ventilatory responses (HCVR). Olfactory neurons impairments were achieved pharmacologically with the injection of GABA-A agonist muscimol (2 mM) in the OB or OE or genetically by using the Ric-8b conditional knockout mice. Ventilation (VE) was measured by whole-body plethysmography in conscious unrestrained mice. Pharmacological blockade with muscimol in the OB (VE: 320 ± 63% vs. saline: 259 ± 44) or in the OE (VE: 491 ± 71 vs. saline: 351 ± 50%) produced a higher HCVR in conscious mice. Using a genetically knockout mice to the Ric8B (a guanine nucleotide exchange factor), we found a higher HCVR (VE: 460 ± 119 vs. WT: 237 ± 62%) compared to wild-type mice. Our data suggest that the olfactory system plays an inhibitory role in central respiratory chemoreception, as its absence exacerbates CO_2 ventilatory responses.

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P414 Odor prediction of whiskies based on their molecular composition

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Aromas, especially in foods, are an intricate combination of diverse odor molecules with different activity values that create a particular odor impression. Predicting these odors poses a challenge for both automated systems and sensory trained panelists.

In this work, we combine fast analytical assessment tools with human sensory data to train two machine learning algorithms with 16 previously analyzed whisky samples from either American or Scotch origin and make for accurate prediction of whisky odors.

Using OWSum, a linear classification algorithm, we first accurately distinguish the two classes based on the detected molecules, providing an insight on key molecules and molecular structures that position a sample in one of the two classes.

Moreover, using previously acquired human sensory RATA (Rate All That Apply) data from 11 sensory trained panelists, we use OWSum and a convolutional neural network architecture to predict the top 5 odors and RATA scores for each sample with higher accuracies than previously possible for complex mixtures.

We extract molecular substructural similarity features from the molecules detected in each sample using fast analytical methods and weight them by their relative Gas-Chromatography (GC) peak areas as a proxy for their concentration before training our algorithms.

We compared our odor prediction methods with inter-panelist reliability averaged over all participants. Our approach outperforms the average panel performance with mean ROC-AUC score of 0.76 and Mathews Correlation Coef. of 0.65.

Considering the small training data set, this is a very promising odor prediction accuracy and demonstrates the value of our approach.

P415 Olfactory bulb activity and active sniffing during naturalistic foraging in freely moving mice

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Understanding the critical role of the olfactory system in guiding naturalistic foraging behaviors promises to provide fundamental insights into sensory perception and ecological adaptations. Mice rely heavily on their olfactory senses to navigate complex environments and locate potential food sources. Although odor-evoked activity has been intensively studied in head-fixed animals, little is known about the dynamic sensory signals acquired by freely moving aniIals when actively sampling their environment. To address the gap in knowledge about real-time olfactory sensory-motor strategies, we engineered a novel head-mounted miniscope with an expanded field of view allowing us to bilaterally imagI glomerular activity in the main olfactory buIb (MOB). MOB imaging in freely moving animals revealed that sensory information was largely confined to a relatively small distance within 10 cm of the odor source. Average glomerular activation in the MOB increased as animals approached odor sources, allowing us to map well-studied concentration-dependent coding onto spatial distance measures. Interestingly, glomerular activity often showed directional tuning near the odor source, and these signals appear to inform future turning behavior. Odor-evoked activity was often temporally sparse, suggesting animals only obtain sensory information on a subset of sniff samples. To directly relate sniffing activity to behavior and neural activity, we implanted thermistors to track sniffing during foraging, which reveals a complex relationship between movement speed and directional changes. Currently, we are integrating sniff measurements and MOB miniscope imaging to test how active olfactory sampling strategies relate to both sensory-driven activity in the MOB and ongoing moment-to-moment navigational decisions.

P416 Anorexia Nervosa and Anxiety to Eat: The Influence of Olfactory Responses to Food Odors

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Olfactory cues from higher energy dense food (HED) typically elicit positive food anticipatory and consummatory responses. However, in individuals with anorexia nervosa (AN), such cues may trigger conditioned negative responses such as anxiety to eat (AtE) leading to maladaptive eating behaviors. Here we assessed olfactory performance (intensity, liking, identification) and odor-elicited AtE using a series of visual analogue scales in women with AN (N=21) and healthy control women (HCs; N=35). Women with AN were tested at hospital admission (T1) and after behavioral treatment with weight restoration (T2; BMI$\geq$19). HCs were tested five weeks apart. Following an overnight fast, participants were presented with suprathreshold concentrations of 16 odors (Sniffin' Sticks) across three categories—

HED odors, low energy dense food (LED) odors, and nonfood odors. Participants were not told the identity of the odors. The AN group reported greater odor-elicited AtE relative to HCs across all odor categories. Greater odor-elicited AtE was observed to HED relative to LED and nonfood odors in AN, whereas greater odor-elicited AtE was observed to nonfoods relative to HED and LED odors in HCs. Intensity, liking, and identification scores were similar between groups across categories. Scores did not differ at T1 and T2. These data suggest that women with AN experience greater HED odor-elicited AtE relative to HCs, which is not due to enhanced olfactory performance or hedonics, and may be resistant to behavioral treatment with weight restoration. Odor-elicited AtE may contribute to maladaptive eating behaviors (e.g., maintaining a rigid low-calorie diet) and introduce treatment challenges in AN.

P417 Parallel genetically-distinct basal amygdala pathways route affective information to ventral striatum subregions

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The basolateral amygdala (BLA) is a critical mediator of emotion and its diverging projections into higher-order and other limbic structures have emerged as key factors for modulating affective states. Previous work established the differential roles of distinct BLA cell populations in affective responses and have demonstrated how these single cell populations can bidirectionally control behaviors through their diverging projection targets. Two of the known genetically-distinct populations of BLA projection neurons express either the *drd1* or *drd2* genes, encoding for the dopamine D1 or D2 receptors, respectively. Here, using a combination of viral tracing, *ex vivo* brain slice recordings, chemo- and opto-genetics, and behavior, we identified that the D1+ and D2+ BLA neuron populations form a parallel pathway for the bidirectional modulation of affective states depending upon their ventral striatum projection target. These neurons arise from the basal nucleus (BA) of the BLA with D1+ BA neurons monosynaptically exciting predominately D1+ ventral striatum neurons, and D2+ BA neurons non-preferentially exciting a small population of D1 and D2+ ventral striatum neurons. These two distinct pathways differentially influence affective states, and do so depending upon where they synapse – with divergent contributions of D1+ and D2+ BA to NAc vs BA to TuS neurons. Overall, these results contribute to a model whereby parallel, genetically-distinct, BA to ventral striatum circuits inform emotional states in a projection-specific manner and altogether expand our appreciation for how the BLA regulates olfactory emotions.

P418 Integration of taste information along the gustatory pathway

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Taste information processing has been explored at each level along the gustatory neural axis, yet how taste information evolves along this axis remains largely unclear. Here, we developed a method for a comprehensive survey of the neural representation of taste across multiple brain regions in mice. We generated and utilized transgenic mice expressing the light-gated cation channel channelrhodopsin-2 in

taste buds under the control of the *Calhm1* promoter. Under neuroleptanalgesia and muscle relaxation for conscious sedation, analgesia, and elimination of tongue movements, blue light illumination of the tongue evoked significant fluctuations in the local field potential within gustatory brain regions. This aided in accurate electrode positioning. Subsequent large-scale electrophysiological recordings collected neuronal responses to canonical tastes using consistent techniques and criteria, allowing comparison of neuronal activity across regions. We found that populations of generalist neurons (responsive to multiple taste qualities) and specialist neurons (responsive to one taste quality) varied among regions. Notably, optogenetically evoked spiking in generalists was higher than in specialists, suggesting that generalists result from the integration of gustatory signals. Moreover, the diversity of neurons that exhibit distinct response patterns to taste stimuli peaked in the gustatory cortex, indicating that processing along the gustatory axis culminates in the representation of rich taste information. These findings suggest that combining large-scale electrophysiology with targeted optogenetics in taste buds is a powerful approach for elucidating the hierarchical logic of gustatory information processing in the brain.

P419 Exploring Novel Ways To Improve Eating Experiences For Those With Smell And Taste Disorders

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The inability to appreciate flavour and the consequent reduced enjoyment of food is a significant problem for those living with Smell and Taste Disorders (SATDs). From a different research domain, it has been shown that the sensory and hedonic properties of food can be influenced by modalities separate to smell and taste. In the study here, we aimed to combine these two different areas to understand whether changing the way food was served, can alter its perception in those with SATDs.

Individuals (N=33) with SATDs completed an odour threshold test, followed by a series of tests where snack food was presented in three contrasting modalities (Vision-colour, Texture-food shape, Sound-music mood) and ratings made on sensory/hedonic dimensions. Participants also completed the Olfactory Disorders Questionnaire (ODQ) and a novel measure on their current Food Eating Practices (FEP). We found for vision, that food was rated as higher in pleasantness when served from a blue compared to yellow bowl and saltier in the yellow versus green bowl (latter only for those with low odour sensitivity). For sound, individuals with high (but not low) odour sensitivity rated the food as more pleasant with neutral versus sad music and more generally, perceived the food to be sweeter. The FEP revealed that the most frequently reported strategy to make food more enjoyable was to use different food textures and the addition of herbs/spices. This study provides modest evidence for the potential to use different modalities to make food more enjoyable for those living with SATDs.

P420 Substitution of olfaction by trigeminal stimulation in patients with loss of smell: technological proof of concept and preliminary results

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Loss of the sense of smell is a sensory impairment which has major consequences in many areas of daily life: eating, sensory pleasure, social life and danger detection. To date the main therapies are surgery, medication or olfactory training, but a prosthesis-type technology enabling patients to sample their olfactory environment has not yet been developed. The aim of this study was to develop a proof of concept for such a device. The hypothesis tested in this work was that stimulation of the intranasal trigeminal system by a device that captures odorant molecules and transforms the chemical information into an electrical signal will enable patients to detect and discriminate odorant molecules via this substitution pathway. To test this hypothesis a device that combines an artificial nose with an electrical stimulator positioned in the nasal cavity has been developed. Two experiments involving normosmic individuals and patients with olfactory loss showed that individuals were able to detect their olfactory environment using the device. For discrimination, the results are less clear-cut, but show that a majority of patients can distinguish between two o'orous molecules. Further experiments are underway to improve patients' discrimination performance by adjusting electrical stimulation parameters such as amplitude, duration and frequency. Taken as a whole, this study should be seen as a demonstration of feasibility, with the next big step being to miniaturise the device.

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P421 Taste cells expressing Ionotropic Receptor 94e reciprocally impact feeding and egg laying in Drosophila

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Chemosensory cells across the body of *Drosophila melanogaster* evaluate the environment and play a crucial role in neural circuits that prioritize feeding, mating, or egg laying. Previous mapping of gustatory receptor neurons (GRNs) on the fly labellum identified a set of neurons in L-type sensilla defined by expression of *Ionotropic Receptor 94e* (IR94e), but the impact of IR94e GRNs on behavior remained unclear. To understand their behavioral output, we used optogenetics and chemogenetics to activate IR94e neurons and found that they drive mild suppression of feeding but enhanced egg laying. *In vivo* calcium imaging revealed that IR94e GRNs respond strongly to certain amino acids, including glutamate. Furthermore, we found that IR94eis necessary and sufficient for the detection of amino acid ligands, and co-receptors IR25a and IR76b are also required for IR94e GRN activation. Finally, *IR94e* mutants show behavioral changes to solutions containing amino acids, including increased consumption and decreased egg laying. Overall, our results suggest that IR94e GRNs on the fly labellum discourage feeding and encourage egg laying as part of an important behavioral switch in response to certain chemical cues.

P422 Disgust is sensorial! Research on disgust sensitivity with no sense measures is nonsense.

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From among the basic emotions, disgust has the strongest and direct ties with chemosenses. Its primary function is to detect cues for poison or decay in the food we consume. The most crucial for this task are the senses of smell and taste, however visual, tactile, and auditory stimuli are also relevant in eliciting disgust. Unfortunately, most studies on disgust rely on questionnaire-based measurements of disgust sensitivity, and that applies both to online and lab-based research. Here, I show the results of two studies of mine (N = 361 and 299) in which both disgust sensitivity questionnaires and actual sensorial disgust elicitors were used. The first study, conducted online, comprised two of the most widely used disgust sensitivity scales, namely Three Domain Disgust Scale and Disgust Scale-Revised, and of original auditory and visual scales aimed at evoking disgust. The second study, based in a lab, used visual, olfactory, taste, and tactile disgust elicitors, along with the two aforementioned questionnaires. I show that sensorial measures of disgust work just as fine as the questionnaires, and that applies to separate scores of individual senses and to a combined multisensorial score. Given the ecological and theoretical superiority of sensorial stimuli-based disgust sensitivity measures, which are unambiguous and independent from one's imagination capabilities, I argue for the spread of this approach in the future studies, which is in great need both for the regular western samples, and in the cross-cultural non-WEIRD designs.

P423 Uncovering the olfactory space: from different assessment methods to interpretable concept embedding models

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Olfactory perception requires mapping unique chemical information to our internal representations of objects (e.g., strawberry), categories (e.g., food), and concepts (e.g., pleasantness). However, in contrast to other sensory modalities, it is not well understood which core dimensions form our olfactory space and how to reliably discover them. Here, we propose addressing this challenge by studying olfactory representations as representations of (dis)similarities. Our aims were to identify a reliable method for studying olfactory dissimilarities and to describe the underlying dimensional structure revealed by the best model.

Ten participants performed three tasks with 16 different odorants to derive such dissimilarities: (1) feature rating of each odorant according to 8 features, (2) rating of pairwise dissimilarities between odorants (120 pairs) and (3) the triplet-odd-one-out task (TOOO), where participants choose out of an odorant triplet the one that differed most from the others (560 triplets). The three experiments were repeated after at least one week's break. For each task, we quantified pairwise dissimilarities from the responses to obtain representational dissimilarity matrices (RDMs). Crucially, the TOOO task revealed the most informative RDMs and the highest retest reliability out of all three tasks.

In a second step, we trained a concept embedding model on the TOOO data. The model provided interpretable and reproducible dimensions characterizing the odorants and predicted dissimilarity structures with high accuracies using only a subset of possible triplet combinations for training. Overall, our findings demonstrate the potential of AI to derive dissimilarity structures between odorants and to discover meaningful dimensions of olfactory representations.

P424 Development of a 3R-Model to analyze the Neuronal Activity of the Grueneberg Ganglion

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The mouse olfactory system comprises olfactory sensory neurons (OSNs) distributed across multiple olfactory subsystems, which differ morphologically and functionally. The Grueneberg ganglion (GG), an olfactory subsystem located at the tip of the mouse nose, consists of thermosensitive neurons specialized in detecting chemical danger cues. Given this dual sensory nature, precise analysis of the associated neuronal responses is important. *In-vivo* assays using chemical stimulations with GG-associated cues, like the mouse alarm pheromone 2-*sec*-Butyl-4,5-dihydrothiazole (SBT) or the fox-derived kairomone, 2,4,5-Trimethyl-4,5-dihydro-1,3-thiazole (TMT), induce variable stress levels in recipient mice partially due to difficulties in controlling the surrounding temperature and the proximity of the animal to the source of sensory stimulation. We have now developed an *ex-vivo* assay exploiting the ribosomal protein S6 phosphorylation (rpS6) in OSNs following sensory stimulation. *Ex-vivo* preparations containing living GG neurons, from mice of different genetic backgrounds, were maintained in oxygenated artificial cerebrospinal fluid and conditioned at various temperatures (from 4°C to 37°C). They were then exposed to selected GG ligands such as SBT, TMT. The intensity of the rpS6 signals, observed with confocal microscopy, was quantified. We found that this assay allows the precise temperature control and the simultaneous odorant stimulation of the GG. Our findings demonstrate that the analysis of the rpS6 signal intensity serves as a robust and highly reproducible indicator of neuronal activity within the GG, without subjecting mice to stress. Our technical approach thus aligns with the 3R principles and facilitates the identification of new potential danger signals associated with the GG neuronal circuitry.

P425 The postauricular reflex as a physiological indicator of appetitive olfactory conditioning

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Pleasant smells are potent elicitors of affective responses. They can act as reinforcers signaling which stimuli can be approached, thereby helping organisms navigate their environment. Despite its pivotal function, such appetitive olfactory conditioning has been rarely examined in humans. A potential reason for this gap may arise from a relative lack of sensitivity of the physiological indicators commonly used to measure this learning process. Here, we tested whether the postauricular reflex—a vestigial muscle microreflex behind the ear that is potentiated by pleasant relative to neutral and unpleasant stimuli—is a valid and sensitive physiological measure of appetitive olfactory conditioning. We implemented a differential appetitive olfactory conditioning procedure (N = 55) in which a neutral visual stimulus was paired with a pleasant odor (CS+) that was individually selected for each participant, whereas another visual stimulus was never associated with any odor (CS-). We recorded the postauricular reflex, the startle eyeblink reflex, and skin conductance response (SCR) as learning indices. Results show that the postauricular reflex was potentiated in response to the CS+ compared to the CS-. This potentiation extinguished when the pleasant odor was no longer delivered. Conversely, no conditioning effect was found on the startle eyeblink reflex and SCR. These findings suggest that the postauricular reflex is a sensitive physiological measure of appetitive olfactory conditioning. Measuring this reflex as an index of

appetitive motivation could ultimately foster insights into the psychophysiological mechanisms involved in olfactory and gustatory reward processing.

P426 Optimization of buffer solution composition for electrolyte-gated graphene FET sensor

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Graphene is expected to be applied for highly sensitive chemical sensor, because its electrical properties are significantly modulated by charged substance proximity. Electrolyte-gated FETs are sensor systems for detecting analytes in solution, and chemically stable graphene can be directly exposed to solution without a gate dielectric, making it a promising candidate for high sensitivity. However, its sensitivity is limited by Debye shielding. Although it is well known that a low ion concentration is preferable to reduce the Debye shielding, the lower allowable concentration has not been clarified.

In this study, we demonstrated that the solution potential was stabilized by adding 1 mmol/L KCL to 1 mmol/L HEPES buffer and separating the Ag-AgCL electrode by at least 1 mm from the graphene FET. The optimized solution has a Debye length of 8.3 nm, which is larger than small molecules such as DNA aptamers and odorants. The sensitivity was confirmed using a cation-labeled model molecule attached to pyrene via a 3 nm spacer PEG, indicating that the signal intensity with optimized solution was enhanced four times compared to a buffer solution with a physiological saline concentration. Furthermore, 2-phenylethylamine, a methamphetamine analogue, which could not be detected in physiological saline, was detected at 1 μmol/L.

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P427 Taste novelty is related to bistability of taste processing in gustatory cortical ensembles

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Classically, taste processing is assumed to be innate and stable. But recent evidence suggests that taste perception and coding changes across the first hours/days of familiarization. There is also substantial variability in the dynamics of sensory responses from trial-to-trial, and this variability may itself reflect familiarization of drift, perhaps on a faster time scale. Here, we tested the hypothesis that subtle aspects of taste response dynamics change across the first handful of taste exposures: taste-naïve rats were presented with novel taste stimuli via an implanted intraoral cannula while we recorded taste responses from gustatory cortex (GC); we observed that taste processing in GC ensembles in fact exhibit a “code-switch,” wherein responses to initial trials are characterized by relatively consistent, relatively simple dynamics, that suddenly give way, in later trials, to the commonly-described tripartite pattern. While this

code-switching is also observed in later sessions, its magnitude is much smaller, suggesting that taste-novelty is a key factor in driving code-switching. Converging evidence for this conclusion was observed in rats pre-exposed to sweet taste, in whom the magnitude of code-switching was also greatly reduced. Finally, we recorded rats' consumption of novel tastes in a Brief Access Task experiment mirroring our electrophysiological experiment, revealing that the microstructure of rats' consumption behavior changes across a timescale similar to that of the GC dynamics. Together, these experiments add to a growing body of research demonstrating that taste perception and coding is experience-modulated at multiple timescales.

P428 Physiological analysis of stimulus-dependent signal modulation in mouse olfactory signal transduction

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Adaptation to prolonged or repetitive stimuli is a critical feature of sensory systems, allowing dynamic adjustment of sensitivity. In olfactory sensory neurons (OSNs), activation of odorant receptors and subsequent G-protein-dependent cAMP signaling are balanced by Ca^{2+}/calmodulin-dependent negative feedback, resulting in sensory adaptation. Many OSNs exhibit high sensitivity with activation thresholds in the nanomolar concentration range. Thus, OSN sensitivity spans a range of several orders of magnitude. Whether, beyond adaptation, complementary dose-dependent modulatory mechanisms exist is yet to be identified. Our pilot Ca^{2+} imagi"g experim"nts in dissociated mouse OSNs, using IBMX + forskolin as a "broadband" stimulus, revealed response summation and even potentiation in a dose-dependent manner at short inter-stimulus intervals (ISIs). With increasing stimulus concentrations, the ratio of OSNs with elevated responses decreased, while the ratio of neurons showing adaptation became more prevalent. Here, using patch-clamp recordings from OSNs in acute slices, we compare how changing ISIs and stimulus concentrations affect signal modulation, thus altering action potential discharge and, consequently, information transfer to the brain. Furthermore, we aim to investigate deeper *(i)* which signaling cascade components are modulated during adaptation *versus* summation processes, *(ii)* whether dose-dependence is receptor-(in)dependent, and *(iii)* whether the ability to modulate responses is a stable or dynamic feature of OSNs. Together, we seek to gain insight into how mammalian OSNs shape their odor sensitivity and response strength to cover an extensive range of stimulus concentrations.

P429 Olfactory spatial memory: A systematic review and a meta-analysis

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In this systematic review and a meta-analysis we summarized the paradigms and results of the available research on human olfactory spatial memory, we compared olfactory spatial memory with other senses, and we evaluated the efficiency of an automated screening tool (ASReview) in systematic review preparation. We followed the PRISMA 2020 guidelines, searching three databases (PubMed, Web of Science, and Scopus) on June 15, 2023. We identified 20 articles that complied with our inclusion criteria, from which we identified seven articles eligible for meta-analysis that compared performance in olfactory and visual spatial memory. The meta-analysis utilized a random-effects model with standardized mean

difference as the outcome measure. Results of the systematic review highlighted the ability of humans to memorize locations of odors, especially related to high-calorie food, emphasizing the evolutionary significance of olfaction in guiding spatial navigation towards essential resources. Crucially, results indicated that odors can serve as the landmarks necessary for formation of cognitive maps, which are the foundation for our spatial memory and navigation abilities. Several reviewed studies even implied that a singular process underlies odor recognition and olfactory spatial memory. Results of the meta-analysis showed that human olfactory spatial memory is worse than visual spatial memory, challenging claims that in humans olfaction evolved primarily to aid spatial navigation, and emphasizing the necessity to refrain from generalizing findings from vision to other sensory modalities. Moving forward, addressing methodological variations and further investigation of the neural mechanisms of olfactory spatial memory will be pivotal for advancing this research field.

P430 Saccharides are the key ligands for GPRC5C to evoke the 'off' responses

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GPRC5C is an orphan G protein-coupled receptor (GPCR) that belongs to the class C GPCR family and its expression and function are still largely unclear. In our immunohistochemical study, GPRC5C expression was observed in a subset of type II taste cells containing TAS1R3-positive cells and in some enterocytes and *Gcg*-positive pancreatic α-cells in mice. In Functional Ca^{2+} imaging analysis of HEK293 cells transiently expressing both GPRC5C and the chimeric G protein Gα16-gust44 showed a clear and concentration-dependent intracellular Ca^{2+} increase in response to the removal of the glucose in bath solution, thus generating an 'off' response. GPRC5C also showed similar off responses to the washout of monosaccharides (fructose and galactose), disaccharides (sucrose and maltose) and sugar alcohol (sorbitol) but not to an artificial sweetener (SC-45647) and a sweet-taste amino acid (D-phenylalanine). Altogether, GPRC5C is a candidate for a new chemosensor specifically tuned to sugars and this receptor may contribute to detecting the changes in extracellular glucose concentration in various organs.

P431 Neural mechanisms underlying predator odor-induced persistent defensive behavior

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Life-threatening stimuli induce long-lasting changes in behav'or. For example, when mice are briefly (~1 min) exposed to a predator's odor, they elicit persistent defense behaviors that outlast odor stimulation. While previous studies have explored the neural mechanisms that trigger immediate behavior in response to specific odors, the neural mechanisms that induce sustained defense behavior are not yet fully understood. In this study, we investigated the neural mechanisms underlying sustained defense behaviors in mice. We initially found that exposure to predator odors, unlike neutral and other negative odors, induces anxiety-like behaviors, especially thigmotaxis, that persist even after the odors are removed. A surgical axotomy experiment revealed that the Grunberg ganglion (GG), an olfactory subsystem known as the detector of alarm chemicals, is critical for initiating a persistent defense state. Optical imaging revealed persistent neural activity in the amygdala piriform transition area (AmPir)

following exposure to the predator odors, suggesting that AmPir is a region that translates brief odor input into a persistent defense state. Furthermore, optogenetic suppression of AmPir neurons demonstrated that this sustained activity is important for the maintenance of sustained defensive behavior. The identification of a specialized olfactory pathway from GG to AmPir provides insight into how the brain maintains a state of alertness and defense after the initial threat has passed, highlighting its importance for survival and its potential implications for understanding anxiety mechanisms.

P432 A Mechanism for Olfactory Constancy

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Despite the constant turnover of ORNs, olfactory perception appears constant over time. Here we propose a novel hypothesis where the two-nostril system allows maintaining constancy despite drift in the olfactory image. We propose a winner-takes-all competition between nostrils in pattern identification. If one nostril registers strong identification, the other recalibrates its image accordingly.

To test this hypothesis, we constructed an apparatus containing a 3D-printed barrier between nostrils (to fit each participant's nose), allowing the simultaneous delivery of different stimuli to each nostril.

In this experiment, participants were trained to identify four odors (O1-4). After reaching criteria, O1 was incrementally replaced with a new, unidentified odorant (OX), one nostril at a time, while keeping O2-4 the same. Separate participants completed these tasks without nostril separation to control for learning. After completely replacing O1 with OX, participants named the odors.

The results from the separated-nostrils group revealed a significant effect of the manipulation: In 54% of trials, participants named OX as if it were O1, and named it correctly in only 15% of trials ($z = -6.7, p < .01$). However, comparison with the control group results revealed only a soft trend in the direction of our hypothesis whereby this perceptual shift was greater with separation. Control group named OX as O1 in 50' of trials, and named OX correctly in 23%. The group interaction wasn't significant (OX:$\chi^2 = .41, p = .52$, O1:$\chi^2 = 1, p = .32$). The current data imply a remarkably fast shift in olfactory perception, but only minimally support our hypothesis for the role of the two-nostril apparatus in this process.

P433 Synchronization of the dynamics of smell and sight in perceptual rivalries

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Our experience of the world is inherently multisensory. However, the mechanisms underlying the unity of our perceptual consciousness remain unclear. The phenomena of binaral and binocular rivalries —— stochastic perceptual alternations that occur when different odors or images are presented separately to each nostril or eye —— provide unique windows into the emergence of multisensory consciousness. Using an electroencephalogram (EEG) frequency-tagging technique, we tracked the cortical representations of competing dicoptic images while two odors, each congruent with the competing images, were simultaneously engaged in binaral rivalry. We found an enhanced neural representation during inhalation for the image congruent with the subsequently reported olfactory percept for that inhalation. Conversely,

when the onset of inhalation coincided with the transition of the relative dominance of the competing image representations, the ensuing olfactory and visual percepts also tended to align. These data demonstrate significant multisensory interplays in the generation of the dynamic content of perceptual consciousness.

P434 Untangling Geniculate ganglion and Trigeminal ganglion innervation of lingual epithelium

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Both Geniculate ganglion (GG) and Trigeminal ganglion (TG) neurons convey mechanosensory information and innervate the same regions of taste papillae. Recent studies have identified RET+ neurons from GG and TG that are oral mechanosensory neurons. The four glial cell line-derived neurotrophic factor (GDNF) family ligands (GFLs), GDNF, neurturin (NRTN), artemin (ARTN) and persephin (PSPN), bind to their respective GFRa coreceptors (GFRα1-4) and, as a GFL-GFRa complex, bind and activate RET. We identified GDNF- and ARTN-expressing cells that are located in and around taste buds of fungiform papillae, with ARTN being the predominant GFL expressed within taste buds. We also found that GFRα1 and GFRα3 are expressed on fibers innervating the intragemmal and extragemmal areas of fungiform taste buds, contacting both GDNF+ and ARTN+ cells. To distinguish between RET+ fibers originating from GG versus TG neurons, we compared the RET+ fibers from *Ret*-CreER reporter mice and *Ret*-CreER; *Phox2b*-Flpo dual reporter mice (that selectively label RET+ neurons from GG). Nearly all taste buds have RET+ fibers innervating the extragemmal region in *Ret*-CreER reporter mice, while only 60% of taste buds have extragemmal fibers labeled in RET (GG) dual reporter mice. Lastly, to delineate the relative contribution of GG and TG in providing GFRa1+ and GFRa3+ innervation into the lingual epithelium, we transected chorda tympani (GG) and lingual (TG) nerves unilaterally. Upon analysis of the cut and non-cut sides of the tongue, we determined that most GFRα3 fibers within taste buds are derived from GG, while extragemmal GFRα1 fibers are mostly from TG.

P435 Characterization of adult neurogenesis in the mouse vomeronasal organ

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Neuronal turnover in olfactory epithelia plays a pivotal role in an animal's adaption to its environment. Accordingly, adult neurogenesis in olfactory epithelia persists throughout the lifespan of a rodent. However, the precise physiological processes that govern adult neurogenesis in the vomeronasal organ (VNO) remain elusive. Here, we begin to characterize adult neurogenesis in vomeronasal sensory epithelia. We label newly generated vomeronasal sensory neurons (VSNs) by using a novel genetic approach: upon tamoxifen injection, VSN progenitor cells in *Id2CreER^{T2} :: Rosa26R-tdTomato* mice express tdTomato upon coincident *Id2* promoter activity. Descendants of these cells are thus identifiable by red fluorescence. Using the *Id2* proliferation and differentiation marker as a VSN lineage tracer, we quantify the proportion of new-born neurons within the VSN population. We identify the spatial distribution and morphology of individual new-born neurons along with their age-dependent migration patterns lithin tIe sensory epithelium. Furthermore, our results provide first insights into VSN turnover. Finally, by

analysing marker protein expression in tdTomato-positive cells, we evaluate the differentiation and maturation state of new-born neurons at defined time points post tamoxifen injection.

P436 Prognostication of olfactory performance on psychophysical assessment among individuals with persistent post-COVID-19 olfactory dysfunction

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Introduction: Quantifying the prevalence of persistent COVID-19-associated olfactory dysfunction (OD) remains challenging. Subjective self-reporting of olfactory status fails to provide standardized data capture, evolving SARS-CoV-2 strains demonstrate variability in their penchant to inflict chemosensory impairment, and inconsistent terminology for persistent OD limit our ability to accurately prognosticate olfactory recovery for patients. To inform our understanding of the prevalence of post-COVID OD, we sought to systematically and comprehensively compile psychophysical olfactory data.

Methods: A systematic review of PubMed, Ovid Embase, Web of Science, and the Cochrane Library identified eligible studies in accordance with PRISMA-ScR standards. The primary outcomes of interest were the prevalence (in %) and psychophysical testing scores for individuals with persistent OD (defined as OD ≥3 months) undergoing longitudinal psychophysical olfactory assessment.

Results: Of 583 abstracts screened, 108 underwent full text screen, and 76 studies with a total of 7180 participants were relevant for data extraction. Baseline psychophysical assessment of individuals presenting for care of lingering post-COVID OD suggests a prevalence of 59.63% (SD, 29.17) at 3.35 months, with longitudinal assessments consistent with rates of 35.17% (SD, 20.59) at 5.74 months, 44.99% (SD, 18.75) at 10.19 months, 35.65% (SD, 11.05) at 13.36 months, and 28.87% (SD, 2.21) at 24.17 months.

Conclusions: This study is the first to categorize the percent of individuals with OD at specific time points across the continuum of recovery following SARS-CoV-2 infection. These compiled data suggest that there is a high prevalence of persistent post-COVID OD assessed with validated psychophysical assessment.

P437 Spatial Insights into Olfactory Disorders: Tract-Based Analysis of Altered Connectivity

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In previous investigations, diffusion imaging has been used to gain deeper insights into olfactory dysfunction. This technique primarily assesses the structural integrity of white matter tracts. The present hypothesis postulated the existence of white matter alterations across various etiologies of olfactory dysfunction, providing a means to decipher structural differences. In this particular study, 64 participants were enrolled with diverse causes of olfactory dysfunction. Among them, 23 individuals exhibited hyposmia alongside parosmia-like symptoms (parosmia group), while 27 participants experienced

olfactory loss, stemming from either sinonasal disease or viral infections (non-parosmia group). The methodology employed Tract-Based Spatial Statistics, revealing noteworthy alterations in both patient groups. Key observations centered around the bilateral superior and inferior longitudinal fasciculus. Participants of the parosmia group demonstrated higher fractional anisotropy along these tracts, indicative of better structural integrity. Conversely, the non-parosmia group exhibited heightened mean, axial, and radial diffusivity, suggesting a restructuring in these white matter pathways. The superior and inferior longitudinal fasciculus are known for connecting brain regions associated with cognitive processes, perception, and motor functions. The elevated fractional anisotropy in the parosmia group indicates a potential enhancement in odor perception (better olfactory score) compared to the non-parosmia group. Conversely, the increased mean, radial, and axial diffusivity in the latter group may suggest a potential reduction in odor perception. In summary, our study provides evidence supporting the notion of reduced structural connectivity in olfactory dysfunction, thereby influencing the perception of odors. These findings contribute to our understanding of the relationship between structural alterations and olfactory perception.

P438 A novel method for measuring postural avoidance reactions to odors

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One of the key functions of our sensory systems is to guide us to avoid danger. Sensory information associated with threats can elicit negative emotions, such as disgust or fear, which are strong avoidance cues. Early avoidance is manifested as subtle non-conscious postural reactions of moving away from the source. Despite the ecological value of this basic survival strategy, the underlying mechanisms are still poorly understood. Indirect measures and ecologically less valid tasks have dominated, resulting in very limited generalizability of the results. Here, we used a novel experimental setup based on a 3D camera that enables ecologically valid measures of avoidance behavior with millimeter precision. Crucially, our method allows to measure natural avoidance reactions while keeping”lar’icipants naïve to the purpose of the experiment and unaware of the distance measure being taken by the camera. We presented participants with 6 different odors and asked them to verbally rate their perceived valence on a trial-by-trial basis to identify individual preferences, while standing upright. We found systematic postural avoidance responses to unpleasant odors following odor presentation. Further, we replicated these results using visual stimuli, thereby demonstrating the validity and the general applicability of the measure.

P439 Olfactory transduction cascade elements expressed in a subset of trigeminal ganglion neurons are involved in the management of neuropathic pain.

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Eugenol, extracted from clove plants, is used as an odorant in the sense of smell research and as a natural anti-inflammatory and pain reliever of toothache. While the smell of eugenol is mediated by the olfactory transduction pathway, eugenol’s anti-inflammatory and anesthetic mechanisms are not well

understood, such as modulation of TRP channels (e.g., TRPA1/V1 and TRPM8) or inhibition of voltage-gated sodium channels (Nav1.7).

Analysis of previously published RNAseq data reveals three classes of trigeminal neurons marked by elements of the olfactory signaling. The cluster corresponding to pain fibers (cluster 0; *Trpv1*, *Trpa1*, *Calca* (CGRP), *Scn9a* (Nav1.7)) and cold fibers (cluster 4; *Trpm8*, *Snap25*, and *Scn9a*) showed presence of *Gnal* (G-Protein alpha subunit mediating odorant signaling, Gαolf). Interestingly, cluster 10 expressed many of the olfactory transduction pathway genes (*Gnal*, *Adcy3*, *Omp*, *Cnga2).* All 3 clusters also express some olfactory receptor (*Olfr*) genes. Immunohistochemistry using OMP and CGRP on trigeminal ganglion (TG) of mice expressing GFP under the promoter of the Olfr mOREG, Mor23, p2, or m72 confirmed that the TG neurons express elements of the olfactory transduction pathway.

Calcium imaging experiments shown that trigeminal neurons respond to eugenol, and the concomitant application of eugenol to the trigeminal stimuli capsaicin or menthol reduces the trigeminal neuron activation, which would explain eugenol anesthetic action in reducing pain.

Our data demonstrate the functional presence of the olfactory transduction pathway in TG neurons and suggest the olfactory transduction pathway as a potential target for the management of neuropathic pain to reduce opioid use.

P440 Salivary proteins alter post oral feedback

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A subset of salivary proteins (SPs) are upregulated in response to a diet containing quinine resulting in decreased bitter taste responding and taste nerve signaling. We used 2 paradigms to explore the role of SPs in the gut. In both the animal is given a test solution directly into the gut while licking to a neutral solution. When a bitter solution is infused into the gut, animals decrease on-going intake of a neutral solution (within-session suppression) and learn to avoid the solution that was paired with gastric bitter (conditioned avoidance). To ask if SPs could modify these behaviors, male, Long Evans rats, implanted with gastric catheters, were trained to lick a bottle of Kool-Aid while simultaneously receiving a gastric infusion. Donor saliva was collected from a separate group of rats treated with isoproterenol and combined into a homogenous sample for gastric delivery of SPs. In the within-session paradigm, there was no difference in total licks to Kool-Aid when animals received either water or SPs alone in the gut ($p=0.70$). Licking was suppressed (compared to water control) when rats were infused with quinine ($p<0.001$); however, when infused with quinine+SPs, licking increased to levels equivalent to the control group ($p=0.88$). In the conditioning paradigm, rats showed significant conditioned avoidance of the quinine-paired flavor compared to the water-paired flavor ($p=0.01$). This avoidance was rescued by SPs; rats do not show a conditioned avoidance to the quinine+SPs-paired flavor compared to artificial saliva-paired flavor ($p=0.14$). These data suggest SPs alter post-oral feedback.

P441 Mindfulness training decreases the habituation response to persistent food stimulation

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In contemporary societies, obesogenic environments expose individuals to persistent food stimuli. This exposure leads to a reduction in sensitivity to food odors, thereby reducing the inherent reward and pleasure derived from eating. This could, in turn, drive individuals towards overeating behaviors in pursuit of the same level of enjoyment. Frequent overeating behavior, however, often results in excessive weight gain, which could lead to the development of metabolic and cardiovascular diseases. Mindfulness training emerges as a promising strategy to counteract the sensory desensitization induced by frequent exposure to food cues. By promoting mindful eating practices and enhancing emotional regulation, mindfulness training could enhance sensory perception of food odors and thereby reduce overeating tendencies.

To investigate this hypothesis, a study was conducted with 56 participants prone to stress-induced eating. These individuals were randomly assigned to either a 31-day web-based food-related mindfulness training program or an everyday health-related training program. Utilizing functional magnetic resonance imaging (fMRI) alongside behavioral assessments, data were collected both before and after the intervention period. The findings of this study revealed that compared to health training, mindfulness training significantly attenuated the habituation response to olfactory food stimulation. Moreover, changes in neural activity in brain regions associated with emotional regulation in response to visual and olfactory stimuli were observed.

These results highlight the potential of mindfulness training to heighten awareness of food stimuli, thereby enhancing the enjoyment of eating and mitigating the propensity for overeating. Such interventions offer a promising avenue for addressing the challenges posed by modern obesogenic environments.

P442 Cross-modal associations of human body odour attractiveness with facial and vocal attractiveness: A systematic review and meta-analysis

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Assessing the attractiveness of potential mating partners typically involves multiple sensory modalities, including the integration of olfactory, visual, and auditory cues. However, predictions diverge on how the individual modalities should relate. According to the backup signals hypothesis, multimodal cues provide redundant information. In contrast, the multiple messages hypothesis suggests that different mo'alities provide independent and distinct information about an individual's mating-related quality. The backup signals hypothesis predicts a positive association between assessments based on different modalities, whereas no substantial correlation across modalities is expected under the multiple messages

hypothesis. Previous studies testing the two hypotheses have provided mixed results, and a systematic evaluation is currently missing.

We performed a systematic review and a meta-analysis of published and unpublished studies to examine the congruence in assessments between human body odour and facial attractiveness and between body odour and vocal attractiveness. We found positive but weak associations between ratings of body odours and faces ($r = 0.1$, $k = 25$), and between body odours and voices ($r = 0.1$, $k = 9$). No sex differences were observed in the magnitude of the effects.

Compared to facial and vocal attractiveness judgments, our results suggest that assessment of body odour provides independent and non-redundant information about human mating-related quality. Our findings thus provide little support for the backup signals hypothesis, which the multiple messages hypothesis may better explain.

P443 Contribution of oral cues to ethanol responses in female and male rats

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Sex differences in the propensity to consume ethanol may be driven by oral cues. Here, experiment 1 was designed to test the hypothesis that the oral qualities of ethanol differ in female and male rats. Rats were presented 5 or 10% ethanol followed by administration (i.p.) of either LiCl to induce visceral malaise, or saline control. Generalization of the conditioned avoidance was assessed in a brief-access taste test (10-s trials; 30-min session) with water, 0.03 and 0.3 M sucrose, 0.03 and 0.3 mM quinine and sucrose-quinine mixtures presented in randomized blocks without replacement. Conditioned avoidance of both ethanol concentrations generalized to sucrose and sucrose-quinine mixtures. In experiment 2, ethanol concentrations (1-32%) were presented to a separate cohort following administration (i.p.) of saline, 0.1 or 1.0 mg/kg naltrexone, an opioid receptor antagonist, in brief-access taste tests. Naltrexone administration lowered trials initiated to ethanol, compared to saline injection, for both sexes but decreased unconditioned lick responses to 32% ethanol only for males. Together these findings indicate the oral qualitative profile of ethanol is comparable and that the sucrose-like component is the more salient component in both females and males. Opioidergic signaling that drives the appetitive components of behavior towards ethanol is similar for both sexes but appears to differ for some components of consummatory behavior. Thus, sex differences in ethanol intake do not appear to be primarily driven by variability in qualitative components of ethanol that contributes to consummatory aspects of ingestive behavior, but more likely by reward-related components.

P444 Exploring a Natural Alternative for Repelling Mosquitoes

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Mosquitoes play a pivotal role in the transmission of pathogens that give rise to significant diseases and result in numerous casualties annually. Presently, they thrive in tropical and sub-tropical urban environments across the globe, with their geographic distribution anticipated to expand due to ongoing global phenomena such as climate change and urbanization. Consequently, mosquitoes demand

substantial attention from the scientific community and health authorities, necessitating the development of effective methods for managing insect vectors.

Repellency stands as the predominant strategy for averting mosquito bites and, consequently, curtailing the propagation of arboviruses. Nevertheless, the escalating availability of synthetic repellents has raised concerns regarding their toxicity and environmental sustainability. In this context, botanical-based products have emerged as a promising alternative to synthetic mosquito repellents.

Nootkatone, a compound found in the essential oil of grapefruit peel and Alaskan yellow cedar heartwood, has exhibited potential as an insecticide and repellent against various arthropod species in controlled laboratory settings. However, the precise molecular and cellular mechanisms underlying its action remain undisclosed. Our research efforts centered on the use of genetically modified mosquitoes in behavioral bioassays and a heterologous expression system, with the primary objective of elucidating the molecular targets of nootkatone in *Aedes aegypti*. This endeavor aims to uncover the mode of action of nootkatone, particularly in relation to its repellent properties.

P445 How Glass becomes Odor. Exploring Boundaries of Olfactory Imagination

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The objective of my PhD project is to explore the potential of glass as a medium for olfactory experiences. I aim to demonstrate that training olfactory imagination can enable the recall of odors solely through mental imagery. In this context, implementing a container or vessel symbolizing a physical smell source is substantial. Not only for artistic purposes but also because expectations influence smell experiences. Utilizing glass as a container creates an anticipatory momentum for perceiving a smell. I argue that glass, with its widely recognized attribute of being odorless, eliminates specific smell biases, offering an open position to experience any odors on glass and delving into the olfactory imagination. Building upon studies concerning cross-modal correspondence, I created *Glass Tastings* as multi-sensory, performative experiments to test the influence of shape, color, and texture using the tools of art in combination with narration and glass. Feedback from focus tables, questionnaires, and digital tools supports the findings. Results indicate that glass when combined with language and artistic stimuli, can evoke imaginative smell experiences and the recall of autobiographical odor memories. Stimulus and olfactory responses remain very individual, but overall tendencies can be shown for texture and smell sources included in the narration like earth, coriander, and sweat in combination with drawings. This research contributes to understanding the role of artistic stimuli in activating olfactory imagination and opens up new avenues for immersive sensory exploration through glass.

P446 Electrophysiological characterization of periglomerular cells in the mouse accessory olfactory bulb

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The mouse accessory olfactory system plays a key role in detecting chemosensory signals during conspecific social interactions. Sensory information detected by the vomeronasal organ is transmitted through the vomeronasal nerve to the accessory olfactory bulb (AOB). The AOB consists of mitral cells (projection neurons) and local interneurons, including granule cells and periglomerular cells (PGCs).

Vomeronasal sensory neurons send excitatory synaptic input to AOB mitral cells through multiple glomeruli, which are surrounded by PGCs. However, the specific physiological function(s) of PGCs as well as whether they form a homo- or heterogeneous neural population remains elusive. Here, we investigate the biophysical properties of PGCs using whole-cell patch-clamp recordings from visually identified PGCs in acute mouse AOB slices. In addition, following diffusion loading of PGCs with biocytin, *post-hoc* morphological analysis allows correlation of structural and functional characteristics. To detail cell type-specific features, we analyze passive and active membrane properties, voltage-activated currents, and action potential firing. Our findings reveal unique characteristics of PGCs, providing initial insights into their physiological properties within the mouse AOB. We demonstrate that, given their large input resistance, PGCs are highly sensitive to stimulation. With fast action potential kinetics, PGCs can discharge at high frequencies. In addition, voltage-dependent potassium, sodium, and calcium currents display distinct activation and inactivation properties. Our results provide first insight into physiological characteristics of PGCs in the mouse AOB. Ongoing research in this field will further enhance our understanding of the sensory processing principles in the AOB network.

P447 Oral detection of a fatty acid is enhanced by rinses of the KATP channel closer tolbutamide in humans

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The presence of fat in food can influence preference and liking for it. Oral fat sensations are perceived via somatosensation (mouthfeel) and gustation (fat taste). Our current understanding of fat taste indicates that long chain fatty acids stimulate the receptors CD36, GPR120, and GPR40 on taste receptor cells.

Recent reports revealed the discovery of Adenosine Triphosphate-sensitive potassium (K_{ATP}) channel in human T1R3 expressing taste cells. The taste cell K_{ATP} channel is thought to act as a sensor of metabolizable fuels in the mouth by responding to increased intracellular ATP. Here, we tested the hypothesis that fatty acids elicit taste signals, in part, via a similar metabolic sensing pathway that uses the K_{ATP} channel. We measured fatty acid oral detection thresholds in humans following oral rinses with a K_{ATP} channel closer (signal enhancer) or a channel opener (signal suppressor).

To retain fatty acid molecules in an aqueous phase, we dissolved a fatty acid sodium salt in water. This yields detection thresholds in the low millimolar range. Subjects were able to detect the fatty acid at significantly lower concentrations when treated with tolbutamide (signal enhancer) rinses compared to vehicle rinses (one-tailed t-test, $p \leq 0.02$, n=15). Conversely, diazoxide (signal inhibitor) rinses reliably elevated fatty acid thresholds in 6 out of 8 subjects.

A metabolic signaling pathway in taste cells may influence preference, reward, and liking for foods. Decoding an oral fatty acid metabolic signaling pathway will help elucidate the function of fat taste.

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P448 Olfactory signal guided behavior in Locusta migratoria

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Swarming locusts are major pests that threaten worlds food production. Before swarm formation, locust populations exhibit a dramatic phase change from a solitary to a gregarious phase. The cause of this phase change is a complicated interplay of conspecific and environmental cues. This phase change in the migratory locust *Locusta migratoria*, still not well understood. Here we study the behavior of both solitary and gregarious *L. migratoria* towards the headspace odors of conspecifics. As we do not find a general attraction of gregarious animals to the headspace of gregarious conspecifics, swarm formation does not seem to be mainly governed by olfactory aggregation cues. When testing for potential mating signals, we observe that the headspace of virgin gregarious females is highly attractive only towards virgin males of the same phase, while mated gregarious males and solitary males, regardless of their mating state, do not become attracted. Interestingly, this phase-specific attraction goes along with the finding, that mating behavior in experiments with inter-phasic pairings is extremely rare. Our data suggest that odor emissions in *L. migratoria* play a significant role in a mating context.

P449 Olfactory perception in elevated ozone: the role of ozone reaction products

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In the Anthropocene, increasing concentrations of oxidant pollutants such as ozone have been shown to corrupt odor-driven behavior in insects by chemically degrading plant signals or insect pheromones. The degradation, however, does not only result in a loss of signals but also in a potential enrichment of oxidation products, predominantly small carbonyls. Whether and how these oxidation products afct insect olfactory perception remains unclear. We examined the effects of ozone-generated small carbonyls on the olfactory behavior of the vinegar fly Drosophila melanogaster. We compiled a broad collection of neurophysiologically relevant odorants for the fly from databases and literature and predicted the formation of the types of stable small carbonyl products resulting from the odorant's oxidation by ozone. Based on these predictions, we evaluated the olfactory detection and behavioral impact of the ten most frequently predicted carbonyl products in the fly using single sensillum recordings (SSRs) and behavioral tests. Our results demonstrate that the fly's olfactory system can detect the oxidation products, which then elicit either attractive or neutral behavioral responses, rather than repulsion. However, certain products alter behavioral choices to an attractive odor source of balsamic vinegar. Our findings suggest that the enrichment of small carbonyl oxidation products due to increased ozone levels can affect olfactory-guided insect behavior. Our study underscores the implications for odor-guided foraging in insects and the essential ecosystem services they offer under carbonyl-enriched environments.

P450 Cell-based assays for olfactory receptors and their application

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Our sense of smell plays an important role in our daily lives, especially in food consumption, influencing both food choice and the amount of food intake, as well as in our social activities and interactions, without forgetting our memories. The last three decades have seen great advances in the field of olfaction, beginning with the identification of olfactory receptors (ORs) and their signaling pathways. However the pairing of individual ORs with their cognate ligands has been progressing slowly. This task has been complicated by difficulties in establishing a general functional assay system for ORs due to low expression levels of receptors in heterologous systems, high background signals of some ORs, and low reproducibility for others. We therefore set out to generate, evaluate, and compare different cell-based assays for ORs using different technologies such as CRE-luciferase assay, GloSensor and protein kinase A (PKA)-NanoBiT. In addition, we used our proprietary chAMPion assay, which measures cAMP levels indirectly via calcium influx through cyclic nucleotide gated channels, thereby replicating the native OR signaling pathway.

Aforesaid assays can be easily employed at Axxam for various purposes, such as identifying which olfactory receptors are activated by malodors and leveraging these receptors to pinpoint molecules that can effectively block the activation of the ORs by the malodors. This capability extends to other applications, including the identification of specific OR-ligand interactions and the exploration of potential compounds modulating olfactory responses in diverse contexts.

P451 Active sensation and spatiotemporal remapping in olfaction and vision: parallels and contrasts

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A main goal of sensory systems is to extract behaviorally-relevant information from the physical signals impinging on their receptors. Objects are often static, but – typically due to biophysical constraints – receptors respond better to fluctuating signals than to constant ones. Efficient encoding therefore requires that the frequency range of environmental signals is shifted to match that of receptors' sensitivities. Vision, olfaction, and other senses, including somatosensation, use active sensation to achieve this: like eye movements, antennal movements and sniffing induce temporal changes even when source signals are static, e.g., steady release of odorants into a laminar flow. However, in turbulence, odor transport remaps static signals into rapidly fluctuating ones, and in such environments, sensor movement and sniffing may be less critical. Spatial considerations suggest other contrasts between modalities. In vision, the potential for redundancy across the receptor array is great, since photoreceptors have similar sensitivities and natural scenes have strong spatial correlations. Fixational eye movements largely eliminate this redundancy, and the spatiotemporal remapping they produce also allows vision's high temporal resolution to contribute to fine spatial discriminations. In olfaction, the wide variety of chemical sensitivities of receptors generally prevents redundancy -- except in the specialized system for pheromones. Here, when pheromone concentration is high enough so that pooling of signals is not required for reliable detection, there is a potential for redundancy across the receptor array. One may speculate that in this important special case, antennal movements provide an analogous spatiotemporal remapping, reducing redundancy and facilitating spatial discriminations.

P452 Distribution of interhemispheric projections between the anterior olfactory nucleus and the olfactory bulb

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A key component of sensation is its bilaterality; integration of bilateral sensory information is required for evaluating environmental stimuli. Olfactory information remains lateralized from the olfactory epithelium to the olfactory cortex, while interhemispheric comparisons are performed in the anterior olfactory nucleus (AON) of the olfactory cortex. Although axonal projections from the AON target both the ipsi- and contralateral hemispheres, little is known about the extent and targets of AON projections to the contralateral hemisphere. In this study, we characterized interhemispheric projections from the AON and their functional connectivity with postsynaptic targets in the olfactory bulb (OB).

First, we labeled AON neurons with AAV1.syn.turboRFP and quantified the layer-specific termination of their axon collaterals in the olfactory bulb at both the ipsilateral and contralateral hemispheres. Our analysis revealed a 63.2%±7.6% (n=4, p=0.04) reduction in density of fibers projecting to the contralateral OB. Next, we used a retrograde approach to characterize the spatial distribution of AON cell bodies that project to each hemisphere. Cholera toxin subunit B conjugated to Alexa 647 was injected into one olfactory bulb, and the cellular distribution was compared in each AON. Finally, we sought to characterize the functional connectivity between the AON and the ipsi- vs. contralateral olfactory bulbs. AAV1.syn.ChR2.YFP was injected unilaterally into the AON, and functional connectivity was assessed by light-evoked postsynaptic currents in the olfactory bulb. In granule cells, we found robust light-evoked excitatory and inhibitory currents in the ipsilateral hemisphere; however, we found only inhibitory postsynaptic currents in the contralateral hemisphere.

P453 Development and Validation of an AI-Assisted Electronic Tongue for Discrimination and Sensory Characterization of Coffee

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The food industry has long sought to replicate human sensory capabilities for product development, aiming to eliminate human subjectivity. Electronic tongues (e-tongues) have been extensively explored in recent decades for evaluating solid and liquid foods. In this study, we present a validated AI-assisted e-tongue capable of accurately discriminating products from various categories, namely 41 coffees and 21 cocoa powders. This novel miniature potentiometric tool utilizes low-selective biomaterial sensors deposited on a conventional printed circuit board substrate. By combining hand-crafted features, predictor importance methods and trained classification models, the e-tongue successfully predicts the sensory characterization of a wide variety of samples. The operating principle involves recording transient voltage variations using 16 differently coated electrodes and extracting three features to compare the differences between reference and test solutions. Our results demonstrate that the e-tongue, coupled with a well-trained single regression model, can simultaneously predict the intensity of 13 descriptors for coffee and 10 for cocoa powders. Through rigorous leave-one-coffee-out validation, we reconstructed sensory

profiles of 41 coffee samples with accurate prediction for most attributes (r^2>0.80), hence, closely aligned with trained panel sensory mean scores. Additionally, promising prediction was demonstrated for a range of 21 cocoa powders from different origins, however more cocoa powders are required to reach the level of prediction accuracy observed for coffee attributes. This highlighting the cross-categories potential of the technology This study showcases the potential of data-driven sensing approaches, trained through example, to accurately predict sensory attributes, closely mimicking the capabilities of trained human panelists.

P455 Chemical ecology and olfactory receptors of hemipteran insect plant-disease vectors

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Chemical sensing has extensively been studied in insects such as moths, flies and beetles. Decades of research in this area has revealed a prominent role for odors in guiding nearly all vital behaviors, and results have been applied to pest management strategies, including monitoring, trapping and mating disruption. Considerably less is known about the chemical ecology and chemosensory systems of hemipteran insects, such as psyllids and leafhoppers, that prominently vector plant disease pathogens, such as phytoplasma bacteria. Previous research in our labs identified a role for odors in mediating intraspecific interactions for the pear psylla, *Cacopsylla pyricola*, but a role for host plant volatiles in mediating pear psylla olfactory behaviors has not been rigorously examined. In this study, we investigated the influence of host plant volatiles on pear psylla behaviors. Furthermore, we annotated repertoires of expressed odorant receptors for *C. pyricola* as well as the *Colladonus* leafhoppers, *C. reductus* and *C. geminatus*. Collectively *C. pyricola* and these leafhopper species transmit phytoplasma bacteria that cause Pear Decline and X-disease in pear and cherry trees, respectively. A better understanding of the chemical ecology and chemosensory systems of these species may inform improved pest management strategies aimed at reducing the spread of the phytoplasma pathogens that these insects transmit.

P456 Pleasant odors: a privileged gateway to appease respiration and improve coupling between body and brain rhythms

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At a time when well-being has become a societal priority, understanding how to induce positive emotions through non-pharmacological approaches is of importance. While odors and music are both commonly used to achieve such a goal, these two sensory modalities differ in several respects. Firstly, the olfactory bulb is directly connected to limbic areas, whereas auditory inputs are first processed by a thalamic relay. Secondly, by their intimate link to respiration through olfactomotor efforts, odorants can affect some physiological parameters and thus favor a relaxation state. We therefore hypothesized that pleasant odors have a peculiar capacity to relax, compared to music. Thirty healthy participants were exposed to three 10-minutes conditions: no stimulus (baseline), a pleasant odor and a pleasant music. During each condition, brain activity was recorded using a 32-channels EEG, along with breathing and cardiac activity. Subjective relaxation was assessed using questionnaires. Results showed that pleasant odors decreased respiratory rate and increased heart rate variability, while pleasant music showed the opposite pattern, relative to baseline. This slowing down of respiration rate allowed the brain activity to synchronize with

breathing. On the phenomenological level, there were no difference in subjective relaxation between the three conditions, and both odors and music significantly increased arousal levels, showing an uncoupling between objective and subjective markers of relaxation. These results show a specificity of odors to slow down respiration, leading to a better coupling between body and brain rhythms.

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P457 Reexamining taste cell lifespan using in vivo two-photon laser scanning microscopy

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Historically, taste cell turnover has been evaluated using fixed tissue preparations to estimate average lifespan for the taste bud cell types. However, a more complete representation of lifespan could be captured by tracking the lifespan of each cell across time. This not only permits measurement of variation in lifespan for individual cells, but also for each stage of taste bud cell differentiation. In this study, our aim was to determine if *in vivo* two-photon laser scanning microscopy could be used to measure the lifespan of taste bud cells. If so, what frequency of imaging would be necessary to accurately track the same cells across time? We chose to evaluate type II taste bud cells in $T1R3^{GFP}$ mice. It was determined that type II cells could be accurately tracked using *in vivo* two-photon microscopy with a time between imaging sessions of 48-h. Preliminary analysis concludes that the median lifespan of type II cells was 10-days, slightly longer than the prior reported lifespan of 8-days. Previous studies have estimated cell lifespan beginning at cell division, while our analysis begins at differentiation – so early stages are missed – meaning that type II cell lifespans are likely longer than 10-days. Additionally, repeated observation of type II cells reveals a diversity of cell lifespans: the shortest-lived cells remained in the taste bud for 2-days or less and the longest-lived for 32-days or more. Our findings demonstrate the importance of tracking individual cells across time to gain insight into variation within a cell type.

P458 Loss of olfaction increases susceptibility to a natural enemy in an herbivorous caterpillar

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Insect herbivores such as caterpillars, are under strong selection pressure from natural enemies, especially parasitoid wasps. Although the role of olfaction in host-plant seeking has been investigated in great detail in parasitoids, the olfactory system of caterpillars and its significance in the interaction between plants, herbivores and natural enemies remains poorly understood. In this study, we investigated the olfactory system of *Pieris brassicae* caterpillars and the role of olfactory information in the interaction among this herbivore, its host plant *Brassica oleracea* and its primary natural enemy *Cotesia glomerata*. To examine the role of olfaction, we utilized CRISPR/Cas9 to knock out the odorant receptor co-receptor (*Orco*). We found that KO caterpillars showed an abnormal morphology in the primary olfactory processing center in their brain. This knockout (KO) also resulted in a loss of function in all sensory neurons expressing odorant receptors, leading to a reduced ability of the caterpillar to identify its host-plant. Moreover, *Orco* KO caterpillars exhibited reduced weight gain and a lower survival rate when

exposed to attacks by *C. glomerata*. Interestingly, the KO caterpillars also experienced reduced weight when challenged by parasitoids whose ovipositors had been removed. We further explored the role of olfactory information by identifying the volatile chemicals released by *P. brassicae* caterpillars and *C. glomerata* female wasps. Our results revealed the crucial role of olfaction in caterpillar feeding and their ability to developmentally outpace natural enemies, highlighting the significance of sensory receptor genes in shaping ecological interactions.

P459 New insights into the mechanisms and brain targets underlying pathogen sensing in mice

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Rodents utilize chemical cues to recognize and avoid conspecifics infected with pathogens. Infection and acute inflammation alter the signature of olfactory stimuli emitted by a sick individual. These cues are recognized by healthy conspecifics via the vomeronasal system, triggering an innate form of avoidance behavior. We employed mice in an acute state of inflammation induced by systemic administration of lipopolysaccharide (LPS) to show that the Gαi2^{+} vomeronasal subsystem is required for detection and avoidance of LPS-treated mice. We performed behavioral experiments, subcellular Ca^{2+} imaging, and pS6/c-Fos neuronal activity mapping in both wt and knockout (cGαi2$^{-/-}$, Trpc2$^{-/-}$, V1rab cluster knockout) mice. We found that the active components underlying the sensing of LPS-injected mice are present in the urine fraction but not in feces extract (FE). Detailed analyses of dynamic Ca^{2+} responses in individual VSN dendritic knobs revealed that these cells can discriminate LPS- and PBS-urine (and their low-molecular-weight fractions) as well as LPS- and PBS-FE in a Gαi2-dependent manner. However, only LPS-urine but not LPS-FE evoked avoidance behavior in healthy conspecifics. Sensing and avoidance of sick conspecifics involved the activation of several brain areas – medial amygdala, ventromedial hypothalamus, and periaqueductal grey – in a Gαi2-dependent manner. We also identified the lateral habenula, a brain region implicated in negative reward prediction in aversive learning, as a previously unknown target involved in sick conspecific detection.

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P460 The natural statistics of olfactory perceptual space - The Object and Scene Volatolome.

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The ultimate goal of digitizing olfaction will entail the ability to recreate a large number of “odor objects” using a limited number of molecular primaries. No matter which method is used to identify these primaries, they will need to effectively capture the perceptual space typically encountered by humans. We

want to know what the typical human olfactory world is made of, and what is the cultural/geographical/personal variability of this pallet. In other words, we aim to characterize the natural statistics of human olfactory perceptual space. To begin tackling this, we set out to create a volatolome database for common odor objects (N=200) and scenes (N=100). Each object/scene will be sampled using Gas Chromatography–Time-of-Flight Mass Spectrometry (GC-TOF-MS), will be rated along descriptors by human panel, and will be systematically photographed with aim to create a cross-referenceable database. All the data will be collected in triplicate in Israel, Sweden and Germany, and will be made publicly available. The initial stage of this process is selecting the objects and scenes. We recruited 100 participants in Israel, age 18-75. Each participant was asked to write up to 30 objects and scenes that they associate with an odor. We observed remarkably low variability in responses, which implies that a sufficient olfactory pallet may not necessarily be overwhelmingly large. We conducted GC-MS analysis on the top rated objects. Our results reflect an initial step towards the creation of a volatolome reflecting human olfactory perceptual space.

P461 Subconscious self-other body-odor comparison as a brain mechanism behind the chemistry in social chemistry

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Friends have similar body odors, and body-odor similarity predicts future interaction quality, but the underlying mechanism for this phenomenon is unknown. From rodents to non-human primates, a striking variety of mammals use their own body-odor as a template they compare with the body odors of others, and by the degree of similarity decide who is friend or foe. Following this, we hypothesized that humans subconsciously compare between the smell of themselves and others to estimate body-odor similarity, such that smelling a similar body odor and a dissimilar body odor will result in distinctive brain activation patterns. To test this, we recruitted 45 participants, and manipulated their self-body-odor for 22 days (using Deo candies, Lavender or Rose odors). In the scanning session, subjects were asked to rate to what degree they want to be friends with each of 144 face images using a fast event-related design followed by 24 min resting state scans, while smelling sub-threshold congruent or in-congruent odor. MRI scanning was performed on a 3 Tesla Siemens MAGNETOM Prisma scanner, using a 32-channel head coil. Whole-brain functional images were acquired using the T2-weighted Minnesota multiband-multi-echo sequence. The results indicate higher connectivity in salience/ventral attention network in the congruent self-odor exposure. We conclude that there is a distinct brain activation pattern when smelling congruent body odor, suggesting that self-body-odor may provide a template for the brain, such that humans subconsciously compare between their own body-odor and the body odor of others.

P462 The Mikvah: A pool of social chemosignals

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Chemosignals are volatiles secreted by an individual to affect behavioral, physiological, and hormonal state of other individuals. In rodents and humans, chemosignals can time ovulation. Married Jewish

religious women dip in a water pool known as the Mikvah once a month, 7 days after menses, i.e., coinciding with the LH-surge before ovulation. We test the hypothesis that the Mikvah may serve as a reservoir of high concentration chemosignals that serve to regulate ovulation. Six healthy, naturally cycling women (mean age 31.7±4.55) participated in a pilot study. Participants tracked 5 menstrual cycles: 1 baseline; 3 cycles attending the Mikvah; 1 follow-up. Tracking entailed basal body temperature (BBT), cervical fluids and menses, and ovulation tests. Mikvah attending was followed by hormonal salivary assays and questionnaires. Menstrual cycle length (in days) increased after attending the Mikvah for 3 consecutive months (baseline cycle: mean=26.17±2.14 days, 3rd Mikvah cycle: mean=28.17±2.23 days, t_5=-3.16, p=0.025, Cohen's d=-1.3). The questionnaires, hormonal assays and air and water samples are yet to be analyzed. These results reflect a very small sample. Nevertheless, this pilot effort merits continued investigation of the notion of a chemosignaling role for dipping in the Mikvah. Identification of chemosignaling molecules involved in timing ovulation may provide novel clinical tools relevant to reproduction.

P463 Environmental Enrichment Impacts Individual Taste Preferences

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Environmental enrichment (EE) promotes resilience to stress, enhances cognitive abilities, and increases behavioral variability in rodents. In the taste system, EE leads to the attenuation of conditioned taste avoidance, but the effects of EE on innocuous taste experience remain unknown. Here, we investigate how EE impacts individual taste preferences (and variability therein). It was previously shown that rats lacking EE exposure display variability in their individual taste preferences. We hypothesize that enriched rats will consume unpalatable tastes more frequently than non-enriched controls, as they become less anxiety-prone, without displaying overall greater variability in preferences as a group. We measure licking to a panel of tastes using the Brief Access Task (BAT) for both enriched and non-enriched groups, evaluating their preferences as well as the inter- and intra-individual variability. To verify the effectiveness of our EE protocol, we will measure anxiety and exploratory behavior in both groups using open field and novel object tests. Preliminary results suggest that enriched animals, contrary to our initial hypothesis, prefer palatable tastes less than controls, but lick a similarly small amount to unpalatable tastes. In addition to providing further insight into the impact of experience on taste, my results will determine whether EE should be made a standard animal welfare tool.

P464 Photosuppression of posterior piriform cortex modulates multimodal chemosensory processing in the gustatory cortex

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The perception of flavor is a complex multisensory process that requires the integration of olfactory and gustatory signals. The gustatory cortex is considered a principal site for this convergence, having been shown to represent odor-taste mixtures as distinct from their unimodal components. Insights from multisensory literature underscore the significance of network communication for multisensory integration, with recent findings suggesting that cortico-cortical interactions between the gustatory cortex and piriform

cortex, particularly the posterior piriform cortex (pPC), are fundamental for the processing of complex chemosensory signals. The aim of this study is to investigate the role of the pPC in the gustatory cortex's representation of chemosensory stimuli. We employed a viral approach to selectively inhibit excitatory neurons in the pPC (using AAV-CAMKII-ArchT-GFP) and subsequently recorded single-unit activity in the gustatory cortex of behaving rats following the intraoral delivery of individual odors, individual tastes, and odor-taste mixtures, both with and without photosuppression of pPC. Our preliminary results reveal that inhibiting the pPC significantly altered the responses of approximately 60% of chemoresponsive neurons in the gustatory cortex to at least one chemosensory stimulus. Specifically, photosuppression of the pPC significantly modulated the response to one stimulus in ~55% of neurons, to two stimuli in ~30%, and to three or more in ~15%. Notably, the alterations in neuronal responses were almost equally split between significant increases and decreases in activity during laser stimulation, irrespective of the stimulus category. These preliminary findings suggest a complex and nuanced role for cortico-cortical interactions in the processing of chemosensory information.

P466 Activity-dependent plasticity in the mouse olfactory bulb: effects of prolonged olfactory deprivation and enrichment

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Activity-dependent plasticity has been observed in various cell types in the murine olfactory bulb (OB) following naris occlusion and olfactory enrichment. Reported changes include modulation of immediate early gene expression, alterations in synaptic strength and number, modulation of intrinsic excitability, and structural changes at the axon initial segment (AIS). These mechanisms are differentially adopted by inhibitory and excitatory neurons depending on the duration of the sensory perturbation. Brief sensory manipulations lasting up to a day prompt up/downregulation of inhibitory interneurons, while principal excitatory neurons remain stable. However, the effects of longer-lasting perturbations are less clear.

To address this, adult mice of either sex were subjected over 3-5-7 days to unilateral naris occlusion, or to passive odour enrichment in the home cage with eight monomolecular odorants. Immunohistochemistry and confocal microscopy confirmed successful manipulations by comparing the expression of activity marker pS6 and immediate early gene cFos in OB of occluded/enriched mice with control littermates. Plasticity in dopaminergic (DA) inhibitory interneurons was assessed by staining intensity of tyrosine hydroxylase, while structural plasticity in mitral/tufted cells (M/TCs) was investigated via ankyrinG staining and 3D tracing of the AIS marker. Preliminary analysis suggests successful modulation of activity in both DA interneurons and M/TCs, with more robust activity-dependent plasticity observed in the former.

These findings support previous reports of a major role for interneuron plasticity in sensory systems, acting as "first responders" to counteract changes in peripheral inputs.

P467 Passive Olfactory Training More Effective in Improving Hyposmia Due to Higher Compliance

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A decreased sense of smell (hyposmia) is a common long-term consequence of COVID-19 known to be associated with other negative health effects and complications, such as the inability to detect harmful smells or enjoy the taste of food. Currently, the only recommended treatment for hyposmia is active olfactory training using household odors, a time-consuming method with low treatment completion rates. The present study aimed to develop and optimize a new form of olfactory training consisting of passively administered odors (scented nasal plugs that retain nasal patency). Subjective and objective olfactory ability was assessed in individuals with hyposmia before and after 2 months of olfactory training using either active or passive olfactory training. Our preliminary results show similar olfactory improvement in the two training groups for the individuals that adhered to and finished the training protocol, but significantly higher compliance rates in the passive olfactory training group. Participants undergoing passive olfactory training also report overall greater satisfaction with their treatment. These data suggest that passive olfactory training could serve as a more effective form of olfactory training for treating hyposmia, due to patients' improved compliance and increased tendency to finish their treatment regime.

P468 Stimulus expectations drive conditioned olfactory hallucinations

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Olfactory hallucinations represent a significant portion of experienced hallucinations in both clinical and healthy populations. Empirical studies of auditory and visual hallucinations have used Pavlovian conditioning paradigms to demonstrate that false perception is driven by overly robust representations of stimulus expectations. However, no study has established that a similar mechanism underlies olfactory hallucinations in humans. Here we implemented a conditioned olfactory hallucination paradigm in which we first determined the odor detection threshold of butanol for each participant (n = 46) using an adaptive psychometric algorithm. Participants then completed an odor detection task where on each trial one of two distinct visual cues was paired with either a supra-threshold, threshold, or sub-threshold concentration of butanol, or no odor. In the first three blocks of task trials, one visual stimulus ("strong cue") was paired more frequently with supra-threshold concentrations, and the other visual stimulus ("weak cue") was paired more frequently with sub-threshold concentrations. In the last three blocks both cues were paired most frequently with the no odor condition. We found significantly greater odor detection rates on no odor trials for the strong cue compared to the weak cue in the last block of the task. Importantly, this finding could not be explained by differences in total number of visual cue presentations or other task variables. We thus demonstrate that false odor perception can be enhanced by the expectation of an olfactory stimulus in a Pavlovian conditioning paradigm. Such findings could yield therapeutic insight into the mechanisms underlying pathological olfactory hallucinations.

P469 The role of microbiome in taste modulation: insights from the Drosophila model.

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As animals age, physiological functions decline, impacting taste sensitivity and perception. Taste sensitivity is tied to nutritional behavior and metabolism, exerting a significant influence on overall health. For instance, individuals who are less sensitive to sweetness may be prone to sugar overconsumption, leading to increased risks of developing disorders such as diabetes and cardiovascular diseases.

Despite the apparent link between taste functions and health, the factors underlying inter-individual variation in taste sensitivity and age-related taste decline remain poorly understood. Recent studies have suggested a role for the microbiome in influencing an animal's small and taste functions. The microbiome refers to the collection of microorganisms inhabiting living animals, and each individual carries a unique microbiome profile. Therefore, the microbiome could potentially play a significant role in affecting taste sensitivity in hosts, and variations in microbiome composition may contribute to inter-individual differences observed in taste functions.

To investigate the effects of the microbiome on taste function, our lab employs the *Drosophila melanogaster* model. Specifically, we compared the taste responses of conventional and axenic flies to varying concentrations of sugar using the proboscis extension reflex (PER) assay in different age groups. Our results suggest a significant microbiome effect on sugar taste sensitivity. Using single-cell RNA sequencing, we identified microbiome-responsive genes in the nervous systems associated with taste functions. Together, our findings provide novel insights into the role of the microbiome in taste modulation in flies, with potential implications for other animals.

P470 Aberrant response to odors in children with SHANK3 deficiency

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The *SHANK3* gene encodes a scaffolding protein in the postsynaptic density complex of excitatory synapses. Haploinsufficiency of *SHANK3* is implicated in both autism spectrum disorder and schizophrenia. While olfactory dysfunction is a common clinical feature among various neurological diseases, the olfactory phenotype of *SHANK3* deficiency is little studied. Leveraging the nasal flow variations in natural sniffing, we performed non-verbal assessments of odor valence discrimination in 21 children with *SHANK3* deficiency and 42 age-matched typically developing controls. The control children consistently demonstrated more vigorous sniffing for pleasant odors compared to unpleasant odors. However, children with *SHANK3* deficiency showed an overall reduction in the duration of odor sniffing, with their sniffing patterns failing to differentiate between pleasant and unpleasant odors in terms of velocity, duration, or volume. These findings point to a link between *SHANK3* deficiency and an insensitivity to odor hedonics, indicative of a state of olfactory anhedonia.

P471 Individual differences in Pavlovian olfactory learning

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Compulsive reward-seeking behavior is a hallmark of various common psychological disorders such as substance use disorder or behavioral addictions. Individual differences in Pavlovian learning could represent transdiagnostic models for compulsive reward-seeking behavior. The present study aimed to

examine the two key behavioral phenotypes of sign-tracking and goal-tracking in Pavlovian learning using appetitive and aversive olfactory outcomes, and to investigate their links with compulsive reward-seeking behavior. Participants (*N* = 213) completed a Pavlovian reversal learning task during which visual stimuli were associated with a pleasant odor, an unpleasant odor, or odorless air. The pleasant and unpleasant olfactory outcomes were individually selected out of 15 odors for each participant to control for individual differences in odor preferences and intensity perception and were delivered using a computer-controlled olfactometer. Gaze direction and pupil diameter were measured with an eye-tracker as a behavioral index of sign-tracking and goal-tracking and as a physiological indicator of learning, respectively. Participants also completed a series of questionnaires measuring various compulsive reward-seeking behaviors. Gaze direction analyses indicated that participants varied in sign-tracking and goal-tracking behavior. Individual differences were also found in learning trajectories across the task and in compulsive reward-seeking behaviors. These preliminary results suggest that individual differences in Pavlovian learning may convey differential vulnerability to compulsive reward-seeking behavior.

P472 Associations between intimacy, disgust, and olfactory ability

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Previous research indicates greater olfactory ability is associated with enriched, fulfilling relationships while greater disgust sensitivity can impede interpersonal intimacy by reducing physical intimacy and sexual satisfaction. This is significant as intimacy is integral to maintaining health romantic relationships. However, factors contributing to intimacy remain understudied. The aim of this study was to conduct the first investigation of associations between olfaction, disgust, and intimacy in a single sample. Seventy-four participants aged between 17–56 (*M* = 22.6, *SD* = 7.1) completed self-report surveys that assessed feelings of relationship intimacy and participants' level of pathogen, moral and sexual disgust. Participants also completed a short form of the *Sniffin' Sticks* identification test. Results indicated olfactory ability was significantly positively related to emotional and intellectual intimacy, but this effect did not remain after controlling for disgust and other covariates. Olfactory ability emerged as a predictor of recreational intimacy only after controlling for disgust and other covariates. Contrary to previous findings, higher pathogen and sexual disgust were significantly associated with higher physical intimacy, however only pathogen disgust remained significant after controlling for disgust and covariates. Pathogen disgust was also significantly related to social intimacy and remained a significant predictor in subequent regression analysis. The present study highlights the multifactorial nature of relationships and the need to study various factors that influence intimacy, including and in addition to olfaction and disgust.

P473 The molecular mechanisms of gustatory perception of specialist insects on cruciferous plants to glucosinolates

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Glucosinolates are token stimuli in host selection of many crucifer specialist insects, but the underlying molecular basis for host selection in these insects remains enigmatic. Using a combination of molecular, electrophysiological and behavioral methods, we are investigating gustatory receptors tuned to glucosinolates in *Pieris rapae* and *Plutella xylostella*. It has been proved that sinigrin, gluconapin,

glucoiberin, glucobrassicin, and gluconasturtiin acting as potent stimulants elicit electrophysiological activities in larval maxillary sensilla styloconica as well as in adult tarsal sensilla, implying that glucosinolate receptors are abundant in larval maxilla and adult tarsi. Seven gustatory receptor genes including *PrapGr28* were identified with high expression in female tarsi of *P. rapae*. When ectopically expressed in *Drosophila* sugar sensing neurons, two of them conferred sinigrin and gluconapin sensitivity to these neurons, respectively. RNA interference experiments further showed that knockdown of the two genes reduced the sensitivity of adult medial tarsal sensilla to sinigrin and gluconapin, respectively. Similarly, we detected abundant *PxylGr34* transcripts in the larval head and adult antennae of *P. xylostella*. Functional analyses using the *Xenopus* oocyte expression system showed that *PxylGr34* was tuned to the plant hormones brassinolide and 2,4-epibrassinolide. These studies pave the way for revealing the molecular basis of the relationships between cruciferous plants and their specialist insects. At present, we are focusing on the molecular mechanisms of taste perception of glucosinolates in *P. xylostella* by knocking out gustatory receptors.

P474 The molecular correlates of topographical maps in the vertebrate olfactory bulb

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The vertebrate olfactory bulb exhibits a topographical organization, where distinct odor classes are encoded in spatially distinct regions. This chemotopic (or odotopic) map plays a crucial role in olfactory computations. However, the molecular correlates of this organization in projection neurons and interneurons are not fully understood. By generating and utilizing single-cell and spatial transcriptomic atlases for both zebrafish and mouse, we investigated the molecular correlates of olfactory bulb topography. We identified and matched basic cell types across species, revealing a continuum of gene expression diversity in classes of glutamatergic projection neurons and GABAergic interneurons. This molecular diversity correlates with topographical organization of the olfactory bulb, revealing higher transcriptomic similarity among nearby neurons. Both zebrafish and mouse projection neurons in spatially distinct olfactory bulb zones exhibit a high degree of molecular similarity, clearly different from spatially distant olfactory bulb zones. These molecularly identifiable groups of projection neurons are organized into non-overlapping regions across the dorsoventral and mediolateral axes of the olfactory bulbs. In zebrafish, these regions overlap with zones encoding alarm, food, and social odors. However, interneurons exhibit a different logic of molecular topography. In both species, the major axis of molecular diversity is the depth from the surface of the olfactory bulb, where interneurons at various depths exhibit prominent transcriptomic differences. While we observed no obvious zonal organization of interneuron molecular topography along the dorsoventral and mediolateral axes of the mouse olfactory bulb, the zebrafish olfactory bulb exhibits a prominent separation of molecularly different interneuron groups along these dimensions.

P475 Regulation of juvenile development by gustatory signals in Drosophila

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The chemosensory system plays a central role in regulating feeding behavior, which alters the ingested amount of nutrients and thereby indirectly affects juvenile development. Chemosensory signals can also

alter hormonal states in animals, but potential developmental effects of such neuroendocrine interaction remain poorly understood. Using the fruit fly as a model system, here we describe two examples of how signals from gustatory neurons modulate animal development. One example is a direct connection of gustatory neurons expressing Gustatory receptor 28a to Insulin Producing Cells in the brain, which secrete insulin-like peptides and promote systemic growth during the mid-larval period. The other example involves prothoracicotropic hormone (PTTH)-producing cells in the brain, which stimulate steroidogenesis and thus promote sexual maturation. PTTH-producing cells are innervated by second-order gustatory neurons, which potentially provides a neural basis for the gustatory system to affect developmental timing in flies. *Drosophila* may thus serve as an intriguing model system to investigate the significance of interaction between chemosensory and endocrine systems during animal development.

P476 Novel insights of developing long-lasting flavoured chewing gum as a multimodal training tool for individuals with flavour perception impairment

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The impairment of flavour perception is known for its significant impact on the quality of life (Hummel & Nordin, 2005), and olfactory training has emerged as a promising intervention, showcasing its efficacy in the recovery of aroma perception (Hummel et al., 2009; Konstantindis et al., 2013; Gellrich et al., 2018). However, the existing approaches neglect the intricate dimensions of taste and chemesthetic impairments, a fact highlighted by Parma et al. (2020). Therefore, this study proposed a novel multimodal training tool based on chewing gum that activates multiple modalities simultaneously.

Lemon-flavoured chewing gums were designed to deliver olfactory, gustatory and trigeminal sensations. Twenty healthy participants (age 18-65) were recruited to aid in developing long-lasting flavour for chewing gum. Using Temporal Check-All-That-Apply (TCATA), panellists identified lemon flavour and sweetness as key attributes during chewing gum consumption. During an 8 min regulated mastication and a subsequent 2 min post-consumption, retronasal release of aroma compounds (limonene and citral) were measured in real-time by atmospheric pressure chemical ionisation-mass spectrometry (APCI-MS). Simultaneously, the dynamic perception of sweetness and lemon flavour was assessed by Discrete-Time Intensity (DTI) with triplicated measurements.

The results provided novel insights into the impact of multimodal stimuli on flavour release and perception for chewing gum consumption. The next step is to explore diverse flavours to enhance the training system's complexity. Our ultimate goal is to investigate the long-term efficacy of chewing gum as a multimodal flavour delivery and training tool for individuals with flavour perception impairment.

P477 Distribution and abundance of pathological tau and α-synuclein in human olfactory epithelium.

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Olfactory dysfunction is one of the most common symptoms of Alzheimer's (AD) and Parkinson's (PD) disease, occurring 5 to 10 years before cardinal disease symptoms. In AD and PD, pathological proteins phosphorylated tau (AD) and phosphorylated a-synuclein (PD) accumulate in the olfactory bulb. Glomeruli in the olfactory bulb receive input from axons of olfactory sensory neurons located in the olfactory epithelium, providing a direct pathway between the external environment, and thus pathogens or toxins, and the brain.

We investigated pathological aggregates accumulation and distribution patterns within this pathway in the human olfactory epithelium and olfactory bulb.

Sections containing human olfactory mucosa and bulbs from 13 post-mortem cases were stained with Hoechst, acetylated tubulin, olfactory marker protein, *Ulex Europaeus* Agglutinin I, phosphorylated tau (AT8), and phosphorylated α-synuclein (pS129), and were imaged using a Metasystems VSlide Scanner. We used ImageJ thresholding and regions of interest to quantify and visualize the distribution of pathological aggregates and morphological markers. The results demonstrate that pathological aggregates were present in most cases but were higher in cases with some neurodegenerative disease symptoms. In some cases, pathological aggregates in the olfactory epithelium correlated with accumulations in the olfactory bulb.

Understanding and predicting patterns of pathological aggregations within the human olfactory epithelium might be useful to aid the early diagnosis of AD and PD.

P478 Impact of Odor Familiarity on Olfactory Function Following Olfactory Training: A Study on Japanese Population

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The study aimed to explore whether the familiarity of odors influences olfactory function following olfactory training (OT), a recognized intervention for olfactory dysfunction. Participants were divided into four groups: Control (CG), Original training (OG), Modified training with familiar odors to the Japanese population (FG), and Modified training with unfamiliar odors to the Japanese population (NFG). Over three months, all participants underwent OT. Olfactory function was evaluated using T&T olfactometry, intravenous olfactory test, and Open essence (OE) before and after OT.

Fifty-five patients, with a mean age of 50 years (±17 years), completed the study. Significant improvements were observed in T&T olfactometry and intravenous olfactory test across all groups following OT. However, there was no significant effect observed on OE score. Furthermore, no significant differences were found among the OG, FG, and NFG groups.

These findings suggest that regardless of odor familiarity, OT led to notable enhancements in olfactory function among participants. The study contributes to understanding the impact of odor familiarity on the effectiveness of OT, indicating that both familiar and unfamiliar odors yielded similar improvements. These results underscore the robustness of OT as a therapeutic approach for olfactory dysfunction, regardless of the familiarity of the odors used. Further research could delve into additional factors influencing the outcomes of OT and refine its application in clinical settings.

P479 Testing the limits of human social chemosignal perception

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We can olfactory perceive our own and other's odorprint, health, kinship, emotional status, psychological attributes, and social relations. Moreover, these perceptual states modulate our behavior even in the absence of conscious awareness and constitute partial foundations of our sense of selfhood. Despite the robust nature of these capacities it will be explored if there are limits to human social chemosignal perception. The presentation examines evidence that we can parse our own personal odor from those of others such that we can achieve a second-person olfactory perspective, but only in limited cases. To do so the nature of second person perception will be conceptually elucidated, and a range of different theories will be outlined in examining if and under what conditions we might be said to smell another second-personally. The presentation concludes by analyzing if our limitations in smelling other's second personally is particular to social chemosignaling or attributable to more general properties of olfactory processing such as its spatiality, vagaries of the sensory properties of olfactory objects, synthetic representation format, or lack of attentional modulation.

P480 Frequency-dependent Phase Locking of Tubular Striatum Neurons to the Respiratory Cycle in Behaving Mice

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The timing of action potentials to the respiratory rhythm is important for odor perception. Here we investigate the synchronization of single-unit activities in the tubular striatum (TuS) with the respiratory cycle as mice engage in an odor discrimination task. We used eight-channel tungsten electrode arrays in the TuS to record signal-unit activity, with an intranasal cannula to record respiration simultaneously as mice learned to discriminate odors. We found that odor-responsive neurons exhibited significant phase locking to the respiratory cycle and that this phase-locking was highly dependent upon the respiration rate. For respiration rates below 6 Hz, neuronal spiking predominantly aligned with the late phase of inhalation. For the respiration cycles greater than 6 Hz, phase locking significantly shifted towards exhalation phases. Moreover, in preliminary analyses we found that the phase-locking of spikes to the respiratory cycle became forward-shifted as mice became proficient in an odor discrimination. These findings are in accord with the dynamic modulation of olfactory processing by the respiratory rhythm and suggest an important influence of experience on this effect.

P481 Detecting Olfactory Bulb Activation in Humans Through an Alternative fMRI Method: Application of Arterial Spin Labeling

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While the olfactory bulb (OB) has been extensively studied in rodent and non-human primate models, there remains a paucity of human research in this area. The conventional functional MRI method (gradient-echo echo-planar imaging), one of the most common and powerful imaging modalities for studying human olfaction, detects neural activity through measuring blood-oxygenation-level-dependent (BOLD) activity. However, it faces considerable challenges in imaging OB due to its small size and unique location near the air/tissue interface of the sinuses. This often results in significant signal dropout within the OB due to these high susceptibility effects.

Arterial Spin Labeling (ASL) presents a promising alternative for functional MRI imaging by enabling direct measurement of neurovascular coupling. ASL utilizes magnetically labeled arterial blood water protons as an endogenous tracer to quantify blood perfusion, offering a means to measure neural activity without relying on BOLD contrast. Notably, ASL has demonstrated functional sensitivity in regions with low signal-to-noise ratio and high susceptibility, making it well-suited for imaging OB.

In this pilot study, we developed and optimized an ASL protocol specifically tailored for detecting perfusion signals in the OB region, providing the first report of resting OB blood flow in humans. Furthermore, we employed ASL to investigate neural activation patterns during odor delivery using a block design experiment, aiming to elucidate habituation phenomena within the OB. Our findings highlight the feasibility of utilizing ASL functional MRI to explore OB function in humans, paving the way for further investigations into the human olfactory system and its underlying mechanisms.

P482 Active sensing over multiple sniffs of target odors by odor-specific feedback from olfactory cortex to olfactory bulb: an hypothesis

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Mammals are poor at individuating components in odor mixtures, unless the components arrive serially. One mechanism for odor segmentation involves centrifugal feedback from the olfactory cortex suppressing responses in the olfactory bulb to on-going background odors that have already been recognized. This allows a subsequently added foreground odor to be singled out for recognition (Li 1990, Li & Hertz 2000). This idea naturally explains odor adaptation, and suggests that the feedback signal should be specific to the on-going background odor (or odor mixtures); consistent with data (Zhaoping 2016, Vinograd et al 2017). However, after extensive training, wild-type mice (though not some mutants) can signal the presence of target odors in background mixtures even when the background mixture is novel and arrives simultaneously (and already mixed) with the target odor (Rokni et al 2014, Li, Swerdloff et al 2023). How can the cortex construct the centrifugal feedback needed to suppress a novel background in the target-background mixture? I propose an active sensing procedure over the course of multiple sniffs for target detection. First, a target-specific feedback to suppress the bulbar response to the familiar target is sent, singling out the bulbar signal for the novel background to the cortex. This signal enables the construction of the necessary centrifugal feedback to suppress the bulbar responses to the background in subsequent sniffs, thereby singling out the target for recognition if it is indeed present. Mice are duly observed to use more sniffs for target detection in novel background (Li, Swerdloff et al 2023).

P483 Structured Inhibition Actively Shapes the Representation of Odor Space in the Mushroom Body (MB) of Drosophila Melanogaster

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Inhibition is a core feature of neural circuits. In addition to its global-level functions, including implementing gain control and activity homeostasis, the degree to which selective inhibition act to re-organize neural activity is of intense interest. In the Drosophila mushroom body (MB), an olfactory associative center, inhibition is primarily mediated by a single, GABAergic neuron, the anterior-paired lateral (APL) neuron. Consistent with its all-to-all connectivity with the MB principal neurons, the Kenyon cells (KCs), prior work has emphasized its global action in gain control, critical for maintaining the sparseness of odor representations in the KCs and pattern separation. However, given its non-spiking nature, spatially-restricted activity could serve as a substrate for selective inhibitory interactions between KCs. We imaged odor-evoked calcium activity in the APL neurites in the MB calyx, and found that different odors elicited distinct spatial patterns of activities in the APL, which are stereotyped across individual brains. Simultaneous, dual-color imaging of KC inputs and APL activity further revealed that spatially structured APL activity largely reflects KC input patterns. Functional blockade of inhibition, usinggenetic blockade of neurotransmitter release from the APL, led to reduced sparseness of odor representations in the KCs, as expected, but, unexpectedly, also a non-linear remapping of the relative similarity of the representations of some odor pairs. These observations suggest the APL can mediate selective inhibitionwith characteristic odor tuning, and actively contributes to the restructuring of the odor representational space in the MB in a manner that should predict perceptual relationships in the fly.

P484 Inflammation regulated by IL-17 signaling is associated with taste dysfunction induced by fractionated head and neck irradiation in adult mice

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Taste dysfunction is one of the common complications in patients with head and neck cancer receiving radiotherapy, which can persist for months and even for years after treatment and reduce the patients' quality of life. To understand the mechanisms underlying radiation-induced dysgeusia, a fractionated irradiation (IR) mouse model receiving repeated, low dose X-ray was established and the mice exhibited the most dramatic taste loss 12 days after head and neck IR. We then characterized changes in morphology and gene expression of the taste papillae collected at the most obvious timepoint for taste dysfunction behavior. We observed no significant difference in circumvallate papillae (CVP) depth following IR. However, fractionated IR significantly reduced the number of taste buds and Krt8 positive cells in CVP. Based on RNA sequencing data, GO pathway enrichment analysis revealed that the upregulated differential genes were significantly enriched in inflammatory response and Innate immune response. The cell abundance of macrophages and CD8 positive cells in CVP was found to be significantly increased by ImmuCellAI-mouse analysis. Moreover, KEGG pathway analysis detected that the IL-17 signaling pathway was significantly enriched in irradiated taste papillae with the highest enrichment score and the significantly upregulated expression of Il-17a, S100a9, and Cxcl2 was confirmed by qPCR. Collectively, our data demonstrate that radiation-induced taste dysfunction is associated with inflammation in taste papillae and suggest the critical role of IL-17 signaling pathway in regulating taste bud injury after IR.

P485 Dissecting the behavioural phenotype of Pandanus specialist Drosophila erecta

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Insects rely predominately on olfactory cues when locating food, mate or an oviposition site. Occupying a novel ecological niche leads to rapid evolution of the olfactory preferences and sensitivity with diverging behavioural responses to stimuli.

To study the evolution of the olfactory systems, we explore the differences in the behavioural olfactory responses of two closely related drosophilids —*Drosophila melanogaster* and the recently diverged *Drosophila erecta*. *D. melanogaster* is a cosmopolitan generalist on decaying fruit, whereas *D. erecta* is a seasonal specialist on screw pine *Pandanus candelabrum* and endemic to the swamps of coastal West Africa.

To study the difference in responses to ecologically-relevant odours, we present two behavioural assays — a two-choice odour trap, and a two-choice, high-throughput oviposition assay. We detail the troubleshooting we undertook to consistently study the behaviour of the specialist *D. erecta.*

Using these methods, we determine the choices for single volatile components of the *Pandanus* bouquet and provide evidence of evolved preference for multiple organic compounds. We also determine the reproducibility of previously reported results. We obtained the chemical composition of *Pandanus candelabrum* using gas chromatography-mass spectrometry (GC-MS), notably on wild fruit collected on-site in Burkina Faso, the most faithful representation of the Pandanus bouquet to date.

Together with a functional investigation into the underlying neural circuits (see abstract by Pop *et al*.), we aim to describe evolutionary adaptations during niche specialisation.

P486 The role of TRPM8 in learning plasticity of oral preferences for temperature

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Our recent data collected using a custom brief-access thermo-lickometer showed mice innately prefer to lick cool (<=30°C) over warm (35°C) fluids. Here we studied the plasticity of oral temperature preferences using appetitive conditioning and the role of TRPM8 in experience dependent oral thermal learning. To determine if temperature can serve as a salient cue for appetitive conditioning, water restricted C57BL/6J (B6) mice (*n = 6)* were trained on a 10-day alternating schedule with 15ºC 8% glucose (CS+) and 30ºC water (CS-) offered on brief access trials in our thermo-lickometer. During brief-access tests, water replete mice preferred 15° over 30°C water, demonstrating temperature can serve as a learning cue. A second squad (B6, *n* = 8; TRPM8 knockout (-/-), *n* = 8) was trained with 30°C as the CS+ and 15°C as the CS-. During brief-access tests a third “catch” temperature was added to determine if mice generalized a conditioned preference to 30°C to warmer temperatures. Water-replete B6 and TRPM8-/- mice generalized a learned preference to 30°C water to 33°C, licking both more than 15°C (Friedman’s ANOVAs; $p < 0.05$). This effect trended to show extinction in B6 mice but was retained in TRPM8-/- mice ($p < 0.05$), implying they may be unable to discern the CS+ and catch temperatures. These data begin to show that innate oral thermal preferences in mice can change with ingestive experiences and that TRPM8 is needed to discern fine differences between cool and warmer temperatures during this process.

P487 The relationship between anxiety-induced changes in sweetness sensitivity and cortisol reactivity

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In our research, we have reported that the induction of anxiety suppresses sweetness intensity, and that awareness of induced anxiety enhances the intensity of bitterness. This phenomenon suggests that changes in sweetness may be affected by anxiety at the peripheral level, while changes in bitterness may be influenced by anxiety at the central level. Therefore, this study investigates the effects of anxiety induction on the sensitivity to sweetness and bitterness. In Experiment 1, we measured the thresholds for sweetness (n=28) or bitterness (n=28) following emotional manipulation. Thresholds for sweetness or bitterness were measured in each group after watching a 15-minute video designed to induce anxiety or relaxation. The results showed a significantly higher sweetness threshold under the anxiety condition compared to the relaxation condition ($t(27) = -2.35$, $p = .0266$), supporting the possibility that the influence of anxiety on sweetness occurs at the peripheral level. Also, no significant difference in bitterness threshold was observed between the conditions ($t(27) = 0.88$, $p = .3880$). If changes in sweetness perception due to anxiety are rooted in peripheral effects, it is conceivable that physiological changes in the periphery mediate this phenomenon. Therefore, Experiment 2 focuses on changes in salivary cortisol following emotional manipulation to investigate the relationship between this physiological changes and the sweetness thresholds. Integrating the results of Experiments 1 and 2, we will conduct a more detailed examination of the mechanisms underlying the changes in sweetness perception caused by anxiety.

P488 Use of odors in VR for psychological stress training: concept and preliminary results

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Background: Using odors in virtual reality (VR) stress training for emergency personnel is a relatively new research area. Initial studies indicated a greater sense of presence and thus significantly contributed to creating realistic training environments. However, more research is needed to fully understand the potential benefits and limitations of using odors in VR stress training. Due to the close anatomical connection to the limbic system, olfactory stimuli are suitable for triggering stress by evoking emotions and memories.

Method: The interdisciplinary project team has a) developed a microfluidic odor pump mounted on VR glasses that allows multiple odors to be applied close to the nose without significantly affecting the surroundings. At this moment, the optimization of the dosing process, release rate, location, and residence time of odors were investigated and can be adjusted individually. b) Mission-specific odors for the target group of rescue workers were selected based on expert interviews, and a risk assessment of odors was performed. c) A content-relevant scenario was created in VR with an integrated and automated odor release.

Preliminary results: The odor presentation has already been validated with the micropump system, indicating a good fit for the visual impressions.

Outlook: The planned studies will explore the effects of different odors on immersion, feeling of presence, and stress levels, as well as the optimal timing and intensity of odor presentation during the VR simulation.

P489 Automated and self-initiated olfactory or multisensory operant conditioning in freely moving mice: an open-science project

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Refining behavioural testing is pivotal in systems neuroscience. In recent years, a handful of custom-made automated cages have advanced behavioural protocols for freely moving mice enhancing standardization and automation. However, replicating such cages can be challenging for laboratories with modest budgets and/or without access to in-house mechanical and electronic workshops. To address this, we have developed a fully automated device based on the AutonoMouse cage designed by the Schaefer Laboratory. Our system, which has been fully re-designed to ensure access to low-cost, widely available parts, and open-source software, enables operant conditioning based on olfaction, vision, and audition. It consists of (1) an easily cleanable cage accommodating up to 20 mice, (2) a corridor with a RFID chip reader and a scale for individual mouse identification and weight monitoring, (3) a test chamber providing liquid rewards through a lickometer. The chamber also features a speaker, a touch screen, and a low-cost, custom-made olfactometer with 16 channels (expandable). Parameters like conditioning sensory modalities, stimulus timing, response/punishment times, reward distribution, and trial numbers are customizable via Python code and graphical interface. The device, remotely controllable with behaviour monitored by two cameras, can be easily integrated with DeepLabCut software for automated animal tracking during behaviour. Our open-source design emphasizes affordability and reproducibility, to promote accessibility across laboratories.

P490 Modelling intranasal trigeminal dysfunction

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Chronic nasal obstruction (CNO) is a main complaint in ENT practice. It is often explained by structural deformities or inflamed nasal mucosa. In some cases, little anatomical deformity or mucosal inflammation is present even though patients complain of severe nasal obstruction. Our earlier studies suggested that alteration of the intranasal trigeminal system may cause reduced subjective nasal patency that is perceived via trigeminal receptors located on the nasal cavity's epithelium. These receptors respond to temperature changes, and to chemical substances such as eucalyptol, causing the same sensation of cooling as increased airflow does. The trigeminal system may play a crucial role in the pathogenesis of CNO. To prove its involvement in the perception of nasal patency, we aimed to create a model for the pathogenesis of CNO.

We carried out a double-blind crossover study with 15 healthy participants, randomised for either treatment (local mucosal anesthetic) or placebo (saline solution) for the first study visit, and the opposite treatment for the second visit. We examined the intranasal trigeminal sensitivity using the Trigeminal

Lateralization Task with eucalyptol. We further used questionnaires and Peak Nasal Inspiratory Flow to evaluate subjectively and objectively the nasal patency, respectively.

Trigeminal sensitivity ($p<0.001$) and subjective nasal patency ($p=0.002$) were significantly lower after nasal anesthetic than placebo. No difference was observed for objective nasal patency.

Our preliminary data shows that topical intranasal anesthesia reduced intranasal trigeminal function and is usable as a model of trigeminal dysfunction. The created model opens the doors for future research concerning CNO.

P491 Life, Death, & Cannibalism

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Where there is life, there is death. Death can occur due to a variety of factors, such as lack of resources, disease, predation, and old age. Although death may be a common occurrence, how animals sense and respond to the dead of their own kind (conspecifics) remains curiously unexplored. Utilizing behavioral, genetic, neural, and computational approaches in the fruit fly (Drosophila), **this work seeks to elucidate fundamental questions about how animals sense and respond to the dead**. While death is often viewed as an aversive state, this research uniquely studies contexts in which death has a positive valence, thus generating entirely new findings, as well as re-contextualizing previous work. Zooming out, this research **contributes to a larger, interspecies body of work that has begun to suggest that life, death, and cannibalism are closely intertwined.**