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Quite ordinary retrieval cues may determine free recall of actions☆

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Abstract

Typically, action phrases like "break the match" are recalled better if participants are asked to enact the phrases than if they are just asked to remember them. This difference in recall rates is called the *enactment effect*. In accounts of the enactment effect, the role of differences between action phrases has remained open. In the present paper, it is hypothesized that free recall performance after enactment depends on the presence, during encoding and retrieval, of objects that are interactively encoded with actions and consequently may serve as retrieval cues. This hypothesis was tested in various ways and corroborated in three experiments. Enactment effects were consistently smaller, even nonexistent, for action phrases with objects absent than for phrases where the objects are present in the experimental context during encoding and retrieval.

Keywords: Enactment; Action memory; Interactive context; Free recall

Since the beginning of the 1980s, an increasing number of studies have investigated memory for actions (see Engelkamp, 1998; Steffens, 1998, for reviews). In the typical paradigm, lists of short verb–object phrases like "read the newspaper" and "scratch your head" are learned under various encoding conditions. Participants enact these phrases; they pretend to do so; they imagine doing so; they watch somebody doing so; or they simply learn the phrases verbally. The finding that the first two conditions in which actions are carried out typically provoke better recall than other encoding conditions has drawn most attention (e.g., Earles, 1996; Engelkamp, 1991; Nilsson & Cohen, 1988; Nyberg, Nilsson, & Bäckman, 1991). However, which action phrases drive this phenomenon, and what their crucial features are, is still an open question. It is the topic of the present paper.

The role of objects during the encoding and retrieval of actions

How can the differences between memory performance after (pretence) enactment versus other encoding conditions be explained? We assume, along with others, that information processing during enactment is tied by the task demands of enactment (also see Engelkamp, 1998). Consequently, carrying out actions, as compared to other encoding conditions, ensures semantic processing of task-relevant features of verb–object phrases. This must be so, because semantic processing is a necessary precondition for being able to enact a phrase. In order for an action like "throw the apple" to be carried out on demand its meaning must be understood (cf.

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Helstrup, 1989; Kausler & Hakami, 1983; Wippich & Mecklenbräuker, 1995, for similar arguments). More specifically, enactment brings about item-specific processing (Einstein & Hunt, 1980; Hunt & Einstein, 1981; Hunt & McDaniel, 1993) of the elements of the action phrase that determine the necessary movements, that is, item-specific processing of the verb and, to a lesser degree, of the object—as "apple" needs to be processed only in so far as it modifies the movement of throwing, not with regard to other aspects of its meaning (being eatable etc.). Therefore, planning and carrying out the action necessarily imply, in addition, verb–object relational processing or *unitization* (Graf & Schacter, 1989) of the verb and the object (Engelkamp, 1998; Kormi-Nouri, 1995; Saltz & Donnenwerth-Nolan, 1981; Steffens, 1999).

These assumptions are by now widely shared by researchers in the field of action memory (cf. Engelkamp, 1998; Knopf, 1995; Kormi-Nouri & Nilsson, 1998). They also may seem rather trivial. However, they can explain a range of findings that have been discussed during the first years of action memory research as "surprising" or hard to explain by existing memory theories. For instance, a simple levels-of-processing manipulation for phrases enacted does not always yield differences in memory performance (e.g., Cohen, 1981; Nilsson & Craik, 1990). In other words, the usual "level of processing" in an enactment condition is not increased by a simple semantic processing instruction. This should be so because, in order to be carried out, all actions are already processed on a semantic level (cf. Zimmer & Engelkamp, 1999, for a review of research on action memory and levels of processing). More examples of findings that are not so surprising and not so hard to explain are discussed by Steffens (1998).

On top of the above assumptions that are by now consensual, there is one additional feature that we postulate to differ between an enactment and other encoding conditions; that is, the salience of cues in the encoding situation that may be used as retrieval cues. Retrieval cues are elements of the experimental context that become associated with the to-be-remembered material during encoding and can thus later serve to help recall (cf. Tulving, 1983). To what extent does carrying out actions during encoding increase the association between action phrases and elements of the experimental context? We expect that a high association will be obtained if the object of the action phrase itself is present in the experimental context. For instance, when carrying out the action "knock on the table," the table in the experimental room should become associated with that action phrase with a higher probability than when verbally memorizing the same phrase. Therefore, that table will, after enactment, be able to serve as a powerful retrieval cue in free recall with an increased probability. During verbal learning, no connection is enforced between the concept "table" and its instantiation in the experimental context. Likewise, after carrying out "clap your hands," one's own hands will more likely be a powerful retrieval cue than after verbally learning that phrase (see also Cohen, Peterson, & Mantini Atkinson, 1987; Norris & West, 1990; Nyberg et al., 1991). Enactment does thus have similar consequences as an instruction to form integrated images of the to-be-learned items on the one hand and particular physical features of the experimental room on the other (Eich, 1985). Similar to a story mnemonic or to written transcripts of individual study-phase associations, such retrieval cues enable "some of the functional context of the presentation period to be recovered from memory" (Reddy & Bellezza, 1983, p. 168). Given an increased probability of unitization during enactment, the presence of the object as a retrieval cue should provoke excellent recall of the whole action phrase. This is an instance of a powerful interactive context effect as discussed by Baddeley (e.g., 1982, 1997). Unlike incidental or independent context attributes (see Smith & Vela, 2001, for a review), instead of establishing only a connection between the engram and some incidental context features, interactive context attributes change the resulting engram in a profound way. In the present case, the engram should be more detailed, elaborate, and concrete when objects in the experimental context are encoded. Thus, the availability of objects as cues in the *test* environment is but part of the postulated mechanism. Objects modulate the effect if they are present during learning and test (optimal conditions) or only during learning (still provoking enhanced encoding). This implies that, if phrases with objects in the encoding context are to be recalled in a context that does not contain the study phase cues, there could still be an enhanced enactment effect for them by way of mental reinstatement (cf. also Cohen et al., 1987). Concretely, mentally reinstating the encoding context featuring the table that was there may cue "knock on the table" in an enactment, but not verbal learning condition. In the latter condition, the cue is effective with a lower probability because it was interactively encoded with a lower probability. When it comes to body parts as cues, such as one's own hands, the cues are of course still present if the rest of the context is changed. Besides the fact that their presence cannot be manipulated, we do not draw a theoretically important distinction between body parts and other action phrase objects as cues.

If retrieval cues indeed played an important role for the superior recall of actions carried out, the enactment effect should be larger for action phrases where the objects are present in the environment than for those where the objects are absent. For instance, while body parts are necessarily involved in carrying out actions, they should be superior retrieval cues for action phrases that directly mention body parts such as "scratch your nose" than for action phrases where they are only implied such as (use your hands to) "put on the hat." Similarly, the encoding context should provide superior cues for "point to the window" if there is a window than if there is none, everything else being equal.

The main purpose of the experiments presented below was to test this *cue salience hypothesis*. For compatibility with previous experiments on action memory, we first used typical action phrases from the appendices of published studies. This is important because we intend to contribute to explaining their typical findings. In Experiment 1a, we also mirrored the typical list composition. A minority of the phrases were action phrases with cues involving body parts, the others involved absent objects. In Experiment 1b, 50% of the critical action phrases involved body parts, and 50%, absent objects. In Experiment 2, action phrases with present objects that were not body parts were also included to increase the generality of the finding. In Experiment 3, the presence or absence of objects for given phrases was directly manipulated in an attempt to exert closer experimental control over the cue salience effect. Critical phrases were held constant in this experiment. For instance, "insert the floppy disk" was learned in the presence or absence of a floppy disk in the experimental cubicle. To anticipate, the results of all three experiments are compatible with the assumption that the presence of cues during encoding and retrieval exerts a large effect on the size of the enactment effect in free recall.

Experiments 1a and b

In Experiments 1a and b, we tested the hypothesis that the enactment effect is larger for the subgroup of the to-be-enacted action phrases where the objects are present in the environment than for action phrases with absent objects. Through enactment of the action phrases, environmental cues for concepts that are part of these action phrases should become salient and later be used easily as respective retrieval cues in free recall. Thus, an enactment effect should be found for the subgroup of action phrases in a given list for which such cues are present. There should be less of a difference in free recall rates between an enactment and a verbal learning condition for those action phrases where such cues are not present, namely, for action phrases where participants had to pretend carrying out actions with certain (absent) objects. Thus, an interaction effect was expected for the factors encoding condition and type of action phrase.

Method

Participants

Participants were 84 students (36 females) at the Universität Trier in Experiment 1a and 45 students (23 females) in Experiment 1b who either took part in the experiment voluntarily or in partial fulfillment of course requirements. Their age ranged from 19 to 41 years ($M = 22.87$ years, $SD = 3.89$) in Experiment 1a and from 17 to 31 years ($M = 22.78$ years, $SD = 2.78$) in Experiment 1b.

Materials

For Experiment 1a, 40 action phrases were sampled from available lists of action phrases used in previous studies (Brooks & Gardiner, 1994; Cohen, 1981). Complete lists of all phrases used in the present research are given in the Appendix. To exclude possible confounds with short-term remembering, five of these action phrases were used as a recency buffer and were excluded from all analyses (cf. Steffens, 1999; Steffens & Erdfelder, 1998). As in previous experiments, body parts were the objects of a minority (9) of the remaining 35 phrases, as in "comb the hair." The objects of the other 26 action phrases were selected such that they were neither present in the laboratory nor were they presented during study.[1] An example is "open the umbrella." (German word order was reversed.) The object in each of these action phrases stemmed from a separate semantic category.

For Experiment 1b, 40 new action phrases were selected from the same sources, or they were generated by the experimenters. Six of these action phrases constituted the recency buffer and were excluded from all analyses. The objects of half of the remaining action phrases were body parts, those of the other half were absent. Three action phrases involving body parts and three involving absent objects were presented in the first six positions of the study list. The objects of the action phrases with absent objects were from unique semantic categories.

Procedure

Each experiment lasted approximately 15 min and was conducted on an Apple Macintosh PowerBook. Participants were randomly assigned to the experimental conditions and asked to read thoroughly the instructions presented on the computer screen. All participants were informed that short "sentences" consisting of exactly one verb and one object each would be presented on the computer screen, one after the other, and that they should try to keep these in mind. Participants in the enactment condition were additionally told that they should pretend to enact these "sentences" to improve their memory for them. After the instructions were read and understood, two examples of action phrases were shown, and participants read that they had to keep in

[1] In fact, objects of 2 (Experiment 1a) or 1 (Experiment 1b) action phrase can still be conceived as present in the experimental room.

mind these phrases and, in the enactment condition only, that they had to pretend to carry out these actions.

Each action phrase was then presented for 6 s on the computer screen. With the exception of the recency-buffer phrases, the action phrases were presented to each participant in a unique random order. After the last recency-buffer action phrase had been presented, participants were informed that a memory test would follow immediately. They were told that they had 3 min (Experiment 1b: 4 min) to write down all the sentences they could remember in any order they wished. Finally, participants had the opportunity to be informed about the purpose of the experiment.

Design

The dependent variable was the percentage of action phrases recalled. Independent variables were the encoding condition (enactment vs. verbal learning; manipulated between subjects) and the type of action phrase (action phrases with body parts vs. action phrases with absent objects; manipulated within subject).

In Experiment 1a, given a Type-I error probability of $\alpha = .05$ and $N = 84$, "large effects" of $f = .40$ (cf. Cohen, 1977) were detectable with a probability of $1 - \beta = .95$ for the encoding condition manipulation (between subjects).[2]

Results

Three general remarks concerning the Results sections of all experiments reported are in order. First, as is usually done (e.g., Cohen, 1981; Norris & West, 1991), analyses using a lenient scoring criterion are reported. Action phrases were counted as recalled correctly if the words written down carried the essence of their meaning. More specifically, a phrase was still counted as recalled correctly if the noun or verb recalled was synonymous to the one presented, or if the plural of the noun was recalled instead of the singular, or if the object recalled was very similar to the one presented (as in "mug" vs. "cup"). In contrast, if the meaning of the verb was changed (as in "open the umbrella" in contrast to "close the umbrella") or if the verb–noun pairing was not correct ("pat your hip" instead of "pinch your hip" or "pat your tummy") the phrase was not counted. Six raters went through the scoring until they reached agreement on all items. The results are not substantially altered when a strict scoring criterion is used. Second, for all statistical tests, the α-error level was set at $\alpha = .05$. Consequently, individual p values are omitted. Partial R^2 (R^2_p) is reported as an indicator of the effect size for statistically significant effects (cf. Cohen, 1977). R^2_p is the proportion of variance explained by one factor in relation to the variance not explained by other factors. A multivariate approach was used for the within-subject comparisons. As a consequence, no MSE values are reported for within-subject variables with more than two levels. In our applications, all multivariate test criteria correspond to the same (exact) F statistic that is reported. In addition, the Pillai-Bartlett V is reported as a multivariate measure of effect size for statistically significant effects.

Experiment 1a

Totaled across the types of action phrases, participants in the enactment condition recalled 36% of the action phrases presented, whereas participants in the verbal learning condition recalled 30%, replicating the typical enactment effect. The left half of Table 1 shows the percentage of action phrases recalled after enactment and verbal learning separately for type of action phrase. As shown in the upper left part of Table 1, action phrases with body parts were recalled better in the enactment than in the verbal learning condition. In contrast, as shown in the lower left part, there was apparently no enactment effect for the recall of action phrases with absent objects.

A 2 (encoding condition) $\times$ 2 (type of action phrase) MANOVA, with repeated measures on the second factor, on the percentage of action phrases recalled yielded a main effect of encoding condition, that is, the expected enactment effect, $F(1, 82) = 17.66$, $MSE = 217.93$, $R^2_p = .18$. Additionally, there was a statistically significant main effect of type of action phrase, $F(1, 82) = 16.40$, $MSE = 138.82$, $R^2_p = .17$. Both main effects were qualified by the hypothesized interaction between them, $F(1, 82) = 16.49$, $MSE = 138.82$, $R^2_p = .17$. A subsequent analysis of simple main effects yielded an enactment effect for action phrases with body parts, $F(1, 82) = 25.38$, $MSE = 237.87$, $R^2_p = .24$, but not for those with absent objects, $F < 1$. Similarly, there was an effect of type of phrase in the enactment condition, $F(1, 82) = 33.69$, $MSE = 138.82$, $R^2_p = .29$, but not in the verbal learning condition, $F < 1$.

Table 1
Percentage of action phrases recalled (and standard errors of means) in Experiments 1a and 1b, separately for enactment and verbal learning and for action phrases with body parts and action phrases with absent objects

	Experiment 1a	Experiment 1b
Body parts		
Enactment	47 (3)	59 (3)
Verbal learning	30 (2)	40 (3)
Absent objects		
Enactment	32 (1)	33 (2)
Verbal learning	30 (2)	31 (3)

[2] All power calculations rely on the G·Power-program (Buchner, Faul, & Erdfelder, 1996).

Experiment 1b

Totaled across the types of action phrases, participants in the enactment condition recalled 45% of the action phrases presented, whereas participants in the verbal learning condition recalled 34%, suggesting a typical enactment effect. The right half of Table 1 shows that, again, there was an enactment effect for action phrases with body parts, but not for action phrases with absent objects.

A 2 (encoding condition) × 2 (type of action phrase) MANOVA, with repeated measures on the second factor, on the percentage of action phrases recalled replicated the effects found in Experiment 1a, yielding a statistically significant enactment effect, $F(1,43) = 11.06$, $MSE = 234.66$, $R^2_p = .20$, a main effect of type of action phrase, $F(1,43) = 41.04$, $MSE = 159.60$, $R^2_p = .49$, and an interaction between these factors, $F(1,43) = 10.20$, $MSE = 159.60$, $R^2_p = .19$. A subsequent analysis of simple main effects yielded an enactment effect for action phrases with body parts, $F(1,43) = 19.01$, $MSE = 219.17$, $R^2_p = .31$, but not for those with absent objects, $F < 1$. In the enactment condition, action phrases with body parts were recalled substantially better than those with absent objects, $F(1,43) = 47.13$, $MSE = 159.60$, $R^2_p = .52$, and this difference was also present, but smaller in the verbal learning condition, $F(1,43) = 5.05$, $MSE = 159.60$, $R^2_p = .11$.

Discussion

The data provide striking evidence for the effect of type of action phrase. A substantial overall enactment effect was found in free recall. Had we stopped our analyses here, we would have replicated the typical finding that is usually attributed to the fact that action phrases in general are recalled better after enactment. However, the enactment effect could unequivocally and exclusively be ascribed to action phrases with body parts, and there was no enactment effect for the remaining action phrases with absent objects. This was the case irrespective of the proportion of action phrases with body parts in the list.

These results are compatible with our cue salience hypothesis. Overall enactment effects found in free recall are larger for the subgroup of action phrases where the objects are present (here, body parts) during encoding and test, as compared to the action phrases where the objects are absent. During enactment, present objects become associated with the action phrases more than during verbal learning, and thus, they are better retrieval cues in the former than in the latter case.

In the present study, the enactment effect even was confined to the action phrases with objects. This is a surprising finding, given the robustness of the enactment effect reported in the literature. We offer several explanations for this finding in the General discussion.

It is unlikely that our results depend on the specific action phrases we selected because Experiments 1a and b comprised nonoverlapping materials. Before turning to the findings' implications, it is still important to replicate them with a different kind of action phrases with cues in the experimental context, that is, cues that do not involve body parts. Based on the findings of Experiment 1a and 1b, we cannot decide between the cue salience hypothesis put forward here and the notion that body parts are special. Comparable to self-reference ratings that provoke particularly good recall (Rogers, 1981; Rogers, Kuiper, & Kirker, 1977), self-reference movements may result in higher recall rates. Such a self-reference effect could be a direct extension of the view that motor codes affect memory performance (Engelkamp, 1998). In addition to the memory traces left in the process of efferent neurons' enervation (e.g., to lift a hand) and afferent feed-back of movements carried out (e.g., "hand has been lifted"), afferent signals of passive contacts could leave memory traces (e.g., "nose has been touched"). If this were so, there should be a larger enactment effect for action phrases with body parts than for other action phrases with objects in the experimental context and action phrases with absent objects. To our knowledge, such proprioceptive stimuli are not assumed to influence remembering in any account of action memory. Still, we tested this prediction against the cue salience hypothesis in Experiment 2.

Experiment 2

Experiment 2 was designed to test the cue salience hypothesis using a list of action phrases that also contained action phrases with cues that are not body parts, that is, action phrases using objects in the experimental context (e.g., "point at the door"). The other kinds of action phrases used were, again, action phrases embracing body parts and action phrases with absent objects. In addition, action phrases were used that consisted of verbs only and did not imply a certain object for enactment (e.g., "tie", "steer"). These phrases obviously differ from the other types of action phrases in that they neither embrace an object in the experimental context nor a certain absent object that is to be remembered. If for some reason the processes of pretending to use objects and subsequently being asked to recall them reduced the enactment effect for the respective phrases, there should be a larger enactment effect for verbs only than for action phrases with objects absent. Instead, if the enactment effect can be traced to a self-reference effect for actions with body parts, the enactment effect for these action phrases should exceed that for the other three types of action phrases. If, however, our hypothesis is correct that cues present during encoding and retrieval determine the size of the enactment effect, the enactment effect for action phrases with cues should be larger than for action phrases without cues. Statistically, an interaction between encoding condition and type of phrase was expected.

Method

Participants

Participants were 40 students at the Universität Trier who either took part in the experiment voluntarily or in partial fulfillment of a course requirement. Their age ranged from 19 to 40 years ($M = 23.23$ years, $SD = 4.41$), 25 were female.

Materials

Forty new action phrases were selected from the same sources as in the previous experiment, or they were generated by the experimenters. Four additional action phrases constituted the recency buffer and were excluded from all analyses. The objects of half of the critical action phrases were present, 10 of them were body parts, 10 were not. Ten of the action phrases with no cues present embraced absent objects, the other 10 consisted of verbs only.

Procedure

The procedure was identical to that in Experiment 1 with the following exceptions. The experiment was conducted in experimental cubicles equipped with PowerMacs. Action phrases were presented to the participants in an individually randomized order, with the restriction that in each block of list positions 1–4, 5–8, and so on, one action phrase of each type was presented. We did this to exclude serial position effects that might confound the effects of type of action phrase (cf. Zimmer, Helstrup, & Engelkamp, 2000). Each action phrase was presented for 7 s on the computer screen and participants were given 5 min to recall all the action phrases they could remember. Encoding condition was varied within-subject in a blocked fashion. We balanced which of the action phrases were enacted and which were verbally learned, and we balanced orthogonally whether the to-be-enacted phrases were presented in the first or second half of list presentation and treated this as a control factor in the analyses of results. In addition to the action phrase, "enact" was presented on the computer screen in the respective half.

Design

The dependent variable was the percentage of action phrases recalled. Independent variables were encoding condition (enactment vs. verbal learning) and type of action phrase (phrases with body parts; phrases with present objects; phrases with absent objects; and verbs). Both were manipulated within subject. Given a Type-I error probability of $\alpha = .05$, $N = 40$, and an expected population correlation of $\rho = .10$ between the percentage of enacted and verbally learned phrases recalled, large effects ($f = .40$, cf. Cohen, 1977) for the encoding condition could be detected with a probability of $1 - \beta = .96$.

Results

Whether the to-be-enacted phrases were presented in the first or second half of list presentation showed neither a main effect nor an interaction with any of the design factors, all Fs < 1. Therefore, the data were collapsed across this factor.

Totaled across the type of action phrase, participants recalled 45% of the action phrases enacted and 26% of those verbally learned. Fig. 1 shows that all types of enacted phrases were apparently recalled better than those verbally learned and phrases with body parts and present objects were recalled better than phrases with absent objects and verbs only. Most importantly, the enactment effect seems larger for phrases with cues present than for phrases with cues absent.

A 2 (encoding condition) $\times$ 4 (type of action phrase) MANOVA, with repeated measures on both factors, on the percentage of action phrases recalled yielded a large enactment effect, $F(1, 39) = 38.43$, $MSE = 683.41$, $R^2_p = .50$. Additionally, there was a main effect of type of action phrase, $F(3, 37) = 40.75$, $V = .77$, and the expected interaction, $F(3, 37) = 6.75$, $V = .35$. Repeated contrasts on the interaction (in the order in which type of phrase is shown in Fig. 1, reported from left to right) showed that the enactment effect was of similar size for phrases with body parts and phrases with present objects, $F < 1$; the enactment effect was larger for phrases with present objects than for phrases with absent objects, $F(1, 39) = 18.55$, $MSE = 389.23$, $R^2_p = .32$; and it

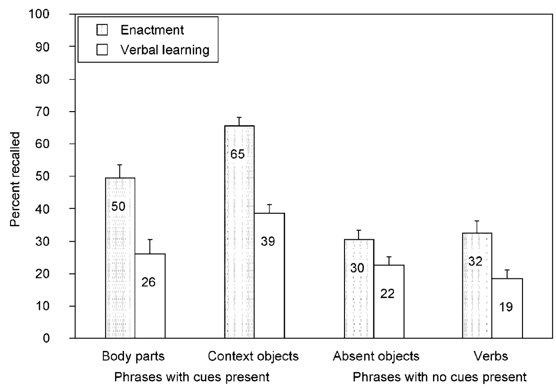

Fig. 1. Percentage of action phrases recalled in Experiment 2, separately for enactment and verbal learning, for action phrases with cues present (body parts or objects in the experimental room) and action phrases with no cues present (absent objects or verbs only). Error bars represent standard errors of means.

was of similar size for phrases with absent objects and verbs, $F < 1.31$. For the sake of completeness, repeated contrasts on the main effect of type of phrase showed that across encoding conditions, recall of phrases with body parts was lower than that of phrases with present objects, $F(1, 39) = 27.36$, $MSE = 593.72$, $R_p^2 = .41$; recall of phrases with present objects was higher than that of phrases with absent objects, $F(1, 39) = 87.52$, $MSE = 594.36$, $R_p^2 = .69$; and recall of phrases with absent objects did not differ from that of phrases with verbs, $F < 1$.

Discussion

We replicated the typical enactment effect once again, and, corroborating our main hypothesis, it was again larger for action phrases with cues than for those without. What is most important about this finding is that we replicated it with a new type of action phrases. The objects of these phrases were present in the experimental context, but were *not* body parts. Thus, our findings are in accordance with a cue salience account, but not with the idea that only body parts provoke increased enactment effects because they increase self-related processing or comprise additional proprioceptive stimuli. If the interaction we have thus far replicated three times could be traced to the processes associated with using and remembering pretence objects rather than to the presence of cues, the enactment effect for verbs only should have been larger than that for action phrases with absent objects. This was not the case.

One may wonder why the enactment effect in Experiment 2 was larger than that in the previous experiments. We speculate that the large enactment effect in Experiment 2 extends the generality of findings from other domains. For instance, generation effects (Slamecka & Graf, 1978; Winnick & Daniel, 1970) in within-subject designs (Begg & Roe, 1988; Schmidt, 1990; Slamecka & Katsaiti, 1987) exceed those in between-subjects manipulations, which are nonexistent or even reversed in many cases (for a review, see Steffens & Erdfelder, 1998). The most surprising finding of Experiments 1a and b was that there was no enactment effect at all for those items for which there were no cues in the experimental context. In contrast, the enactment effect found in Experiment 2, though reduced, was still statistically significant for action phrases with no cues present ($F(1, 39) = 14.79$, $MSE = 327.18$, $R_p^2 = .28$). We thus concede that enactment effects in free recall cannot always be traced completely to the presence of cues in the experimental environment. In our view, enactment should also increase item-specific processing and unitization. In addition, processing goals and strategies must be taken into account. The difference in findings between Experiment 2 and the previous ones may simply point at the role of list composition, or the specific phrases selected, for the size of the enactment effect.

The motivation for carrying out Experiment 3 was to exclude the possibility that the specific phrases used are the basis of the findings we have thus far attributed to cue salience. It seems unlikely that some other factor was confounded with the presence of cues in all experiments reported. However, the modification of enactment effects through action phrase characteristics like familiarity or object use has been the topic of previous research (e.g., Cohen et al., 1987; Knopf & Neidhardt, 1989; Kormi-Nouri, Nilsson, & Bäckman, 1994a; Nyberg et al., 1991). On the basis of existing findings, no definite predictions can be made which action phrases should provoke large enactment effects. Given this uncertainty, it would be nice to obtain more direct evidence of the role of cue salience by holding everything constant but the presence or absence of those cues. Nyberg et al. (1991, p. 223) already suggested that "it will be a challenging future task to develop an experimental setting in which this possibility can be tested." We agree that this is a rather tricky business because we believe that the memory-enhancing consequence of carrying out actions can, in principle, also be obtained in other encoding conditions. That is, if the object cues become salient to participants in a verbal learning condition, then they may also use them as retrieval cues. This will be the case if these cues are very salient in the first place. Obviously, neither body parts nor "natural parts" of the experimental context like the door or the window of the experimental room are so salient. The manipulation of the presence or absence of these cues, however, is impossible a priori. In contrast, cues for typical action phrases with absent objects could be present or absent in a given experimental cubicle. However, a hat, a hammer, a ball, and 17 other things lying on the desk of an otherwise neat experimental cubicle would no doubt be very salient. We would expect all participants to pick up on the relation between those cues and the to-be-recalled list and use them accordingly. If this happened, our manipulation would fail; participants in both encoding conditions would show superior recall of action phrases with cues. Therefore, adequate precautions need to be taken.

Besides such salience, a second way in which participants in a verbal learning condition could become aware of the cues would be a hint in the study phase instruction.

Experiment 3

In Experiment 3, to guard against exorbitant saliency of cues, we manipulated the presence of cues for only a subgroup of the action phrases used, specifically, for two fifths of them. Half of these had cues for a given participant, and half, not. For the next participant, this was reversed. As an additional precaution, these cues were not totally unexpected in the given context, that is, they all were loosely related to the semantic cluster "office and computer." For instance, all participants would learn the phrases "wash out the coffee mug" and "pull the desk light towards you." For half of the participants, a coffee mug would be present in the experimental cubicle throughout the experiment, but no desk light, and thus, recalling "wash out the coffee mug" was counted as an action phrase with an object present, whereas "pull the desk light towards you" was counted as an action phrase with an object absent. For the other half of the participants, this was reversed: A desk light, but not a coffee mug, was present in their cubicle.

In addition, as in Experiment 2, there were action phrases with body parts; action phrases where the objects were present in the experimental context, but were not body parts; and action phrases with absent objects. Because all but the phrases with absent objects lend themselves to being organized in semantic clusters (body parts, objects in the room, and office supplies), all the action phrases with absent objects were also sampled from a loose semantic cluster (kitchen and food-related actions). We expected better recall and larger enactment effects for the types of action phrases for which cues were present in the experimental context, be their presence manipulated or not, than for action phrases with absent objects.

A second purpose of Experiment 3 was to corroborate our prediction that participants in the verbal learning condition can also use these cues if they are made salient. Specifically, a participant in the verbal learning, *context instruction condition*, if instructed to use during study all available cues that might help recalling action phrases later, should be able encode "wash out the coffee mug" with reference to the coffee mug on the desk and then later use that mug as a retrieval cue for that phrase. Thus, the recall of action phrases with objects should be increased in the verbal learning context instruction condition, which in turn should lead to a reduction of the enactment effect for these action phrases. In contrast, such a hint should not substantially affect recall in the enactment condition because it is redundant in that condition. Moreover, the hint should not substantially increase recall for action phrases without cues for the obvious reason that they should not be too helpful as cues for these phrases. We thus expected again an interaction between encoding condition and type of phrase in the standard instruction condition, but not in the context instruction condition. In an analysis involving both instruction conditions, an interaction between instruction condition, encoding condition, and type of phrase was expected especially for phrases where the presence of cues was manipulated directly.

Method

Participants

Participants were 96 students at the Universität Trier who either took part in the experiment voluntarily or in partial fulfillment of study requirements. Their age ranged from 18 to 41 years ($M = 23.35$ years, $SD = 3.70$), 68 were female, 28 were male.

Materials

Thirty-five action phrases were selected from the same sources as in the previous experiments, or they were generated by the experimenters. Five additional action phrases constituted the recency buffer and were excluded from all analyses. The objects of three fifths of the critical action phrases were present, seven of them were body parts, seven were objects that were part of the experimental context, and seven were objects present for half of the participants. The objects of seven other action phrases were present for the other half of the participants. The latter two groups of action phrases encompassed pairwise similar objects (e.g., microphone vs. headphones, waste paper basket vs. cardboard box), a choice that may have had unwanted consequences that we turn to in the Discussion. Concretely, for one participant, "snap your fingers," "point to the door," and "turn on the computer screen" were action phrases with objects present, whereas "clean the mouse pad" and "peel the banana" were action phrases with objects absent. For the next participant, "snap your fingers," "point to the door," and "clean the mouse pad" were action phrases with objects present, whereas "turn on the computer screen" and "peel the banana" were action phrases with objects absent.

Procedure

The procedure was identical to that in Experiment 2 with the following exceptions. Action phrases were presented to the participants in an individually randomized order, with the restriction that in each block of list positions 1–5, 6–10, and so on, one action phrase of each type was presented. Because encoding condition was varied between subjects, no specific instructions were given during list presentation. In the context instruction condition, as compared to the standard instruction condition, two sentences were inserted. Participants were told that present objects could be good memory aids, and that they should try to relate the study materials to such objects, if possible. In the example given, their nose could remind them of "pinch your nose." Experimental cubicles differed with regard to the specific objects present. Two different doors were used, so that a given participant could see only the cubicle she or he was led into. All the objects in that cubicle were present during the whole experimental session, and they were not pointed out to participants, nor were participants asked to use objects like the coffee mug when carrying out actions. In fact, these objects were put just out of participants' reach. That way, a frequent confound of the encoding condition (enactment vs. verbal learning) and the role of objects was avoided (we elaborate on this in the General discussion).

Design

The dependent variable was the percentage of action phrases recalled. Independent variables were instruction condition (standard instruction vs. context instruction), encoding condition (enactment vs.verbal learning), and type of action phrase (phrases with body parts; phrases where the objects are part of the experimental context; phrases where the presence of cues was manipulated, and the cues were present; phrases where the presence of cues was manipulated, and the cues were absent; and phrases with [food-related] absent objects). The factor type of phrase was manipulated within subject. Given a Type-I error probability of $\alpha = .05$ and $N = 96$, a large enactment effect ($f = .40$) could be detected with a probability of $1 - \beta = .97$.

Results

Totaled across the type of action phrase and the instruction conditions, participants in the enactment condition recalled 53% of the action phrases presented, whereas participants in the verbal learning condition recalled 44%, again replicating the typical enactment effect.

The upper half of Fig. 2 shows the results for the standard instruction condition. Most importantly, comparing the size of the enactment effect for identical action phrases for which the presence of objects was manipulated yields obvious support for the cue salience hypothesis. There was a large enactment effect for these phrases in case the objects were present and virtually none if they were absent. As the lower part of Fig. 2 shows, in the conditions in which the instruction made cues salient to all participants, the size of the enactment effect did not differ for identical phrases where the objects were present or absent. However, we concede that this expected finding results from a change not only for the expected subset of action phrases. The enactment effect and the recall score in the enactment condition was also larger, as compared to the standard instruction condition, for action phrases with objects absent. An additional expected finding is that, as contrasted with the standard instruction condition, in the context instruction condition recall scores are higher for participants in the verbal learning condition for action phrases with cues present (38% vs. 35%, 51% vs. 42%, and 68% vs. 53% recalled for phrases with body parts, context objects, and phrases where the presence of cues was manipulated, respectively) whereas these scores have not changed much in the enactment condition (43% vs. 43%, 64% vs. 61%, and 80% vs. 81% recalled). The enactment effect does not seem to differ much for different types of action phrases in the context instruction condition, again confirming our expectation.

A 2 (instruction condition) $\times$ 2 (encoding condition) $\times$ 5 (type of action phrase) MANOVA with repeated measures on the third factor, on the percentage of action phrases recalled yielded a main effect of instruction, $F(1, 92) = 3.89$, $MSE = 136.19$, $p = .05$, $R^2_p = .04$, showing that the context instruction increased overall recall. Moreover, there was a typical enactment effect, $F(1, 92) = 14.21$, $MSE = 136.19$, $R^2_p = .13$, and a main effect of type of phrase, $F(4, 89) = 60.50$, $V = .73$. Furthermore, there was an interaction between encoding condition and type of phrase, $F(4, 89) = 6.60$, $V = .23$, and no other interactions, with all Fs being smaller than that of the three-way interaction, $F = 1.36$. However, the interaction between instruction, encoding condition, and type of phrase was present for the contrast between the two most important types of action phrases, that is, identical phrases where the presence of cues was manipulated, $F(1, 92) = 4.38$, $MSE = 778.25$, $R^2_p = .05$.

Follow-up analyses were carried out on subparts of the design to test other theoretically interesting effects. As expected, the above interaction between encoding condition and type of phrase was present in the standard instruction condition, $F(4, 43) = 6.18$, $V = .37$, but not in the context instruction condition, $F < 1.49$. In the standard instruction condition, repeated contrasts on the interaction (in the order in which type of phrase is shown in Fig. 2) showed similar-size enactment effects for the three types of action phrases with cues, both $F\text{s} < 2.38$. As expected, however, the enactment effect was larger for identical phrases when the cues were present rather than absent, $F(1, 46) = 11.04$, $MSE = 745.96$, $R^2_p = .19$. For the two types of action phrases without cues, enactment effects were not significantly different, $F < 1.10$. In the context instruction condition, the size of the enactment effect was not modified by the type of phrase, as repeated contrasts confirmed, all $F\text{s} < 2.38$.

In a separate analysis of the three types of action phrases with cues, in the enactment condition, the context instruction did not increase recall, $F < 1$. In contrast, the context instruction increased recall of phrases with cues in the verbal learning condition, $F(1, 46) = 3.81$, $MSE = 261.74$, $p < .06$, $R^2_p = .08$. In turn, the enactment effect for these phrases was larger in the standard instruction condition, $F(1, 46) = 23.45$, $MSE = 544.51$, $R^2_p = .34$, than in the context instruction condition, $F(1, 46) = 5.01$, $MSE = 764.68$, $R^2_p = .10$. There was no enactment effect, $F < 1$, in a separate analysis of the two types of action phrases without retrieval cues, neither in the standard instruction condition

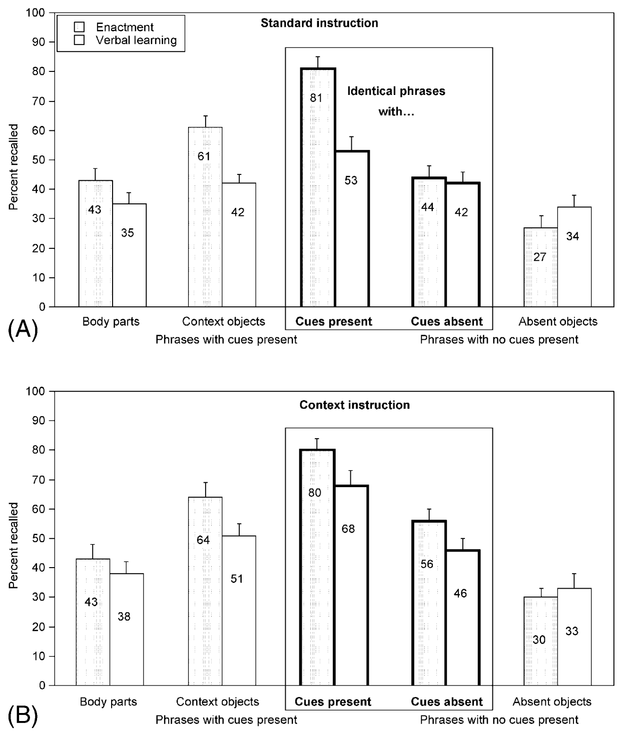

Fig. 2. Percentage of action phrases recalled in Experiment 3, separately for the standard instruction condition and the context instruction condition, for enactment and verbal learning, for action phrases with cues present (body parts; phrases where the objects are part of the experimental context; or phrases where the presence of cues was manipulated, and cues were present) and action phrases with no cues present (phrases where the presence of cues was manipulated, and cues were absent; and phrases with [food-related] absent objects). Error bars represent standard errors of means

nor in a combined analysis of both instruction conditions.

Discussion

The evidence clearly favored the cue salience hypothesis. The presence of cues during encoding and test moderated substantially the size of the enactment effect. What is new: This was found if the action phrases were held constant and the presence or absence of cues was directly manipulated. Moreover, the experiment showed, as expected, that participants in the verbal learning condition, if told so, could use the cues to a similar degree as those in the enactment condition. Consequently, the enactment effect was no longer moderated by the presence of cues in the context instruction condition, but was of approximately the same size for all action phrases.

The only unexpected finding was that, given a context instruction, participants in the enactment condition recalled more action phrases with absent objects than given a standard instruction—recall of those objects that were present in the *other* experimental groups benefitted from the context instruction. If this finding is not attributed to chance, how could it be explained? As mentioned before, we used pairwise similar objects of which one was present and one not. We suspect that participants created idiosyncratic context cues, sometimes using related objects (CD instead of floppy disk, waste paper basket instead of cardboard box, etc.) as a cue for both action phrases. This unexpected finding notwithstanding, the context instruction condition fulfilled its main purpose. It showed that participants in the verbal learning condition can strategically use objects as cues, if asked to do so in the study phase instruction.

General discussion

In the present paper, we have proposed a previously neglected factor influencing the free recall of actions in a framework in which information processing is tied by the task demands of enactment. There is much consensus, and we agree, that carrying out actions, as compared to other encoding conditions, ensures semantic processing of action phrases. More specifically, it appears that enactment brings about item-specific processing of the elements of the action phrase that determine the necessary movements, that is, item-specific processing of the verb and, to a lesser degree, of the object. Additionally, planning and carrying out the action implies unitization (Graf & Schacter, 1989) of the verb and object. The further assumption we want to add to this framework is that the task demands brought about by enactment increase the probability of the interactive encoding of context elements that can later be used as retrieval cues. Interactive encoding should occur for verb–object phrases where the objects mentioned are present in the experimental context. This processing that enactment "automatically" (e.g., Cohen, 1984) brings about can strategically be obtained in a verbal learning (or other) encoding condition if participants are instructed accordingly.

The main purpose of the present experiments was to test the mnemonic role of cues present during the encoding and retrieval of action phrases. An analysis of subgroups of action phrases as they are found in typical study lists confirmed the hypothesis that an overall significant enactment effect in free recall was larger for those action phrases where the objects are present in the experimental context than for those where the objects are absent. In the present Experiment 1a, the objects present were body parts. For the action phrases where the objects were absent, no enactment effect was found at all. This finding was replicated with a different list composition and different action phrases (Experiment 1b); it was replicated for action phrases with cues that are not body parts (Experiment 2); and it was replicated if, for action phrases held constant, the presence of cues was directly manipulated (Experiment 3). As expected, if the cues were pointed out to all participants, the free recall of action phrases with cues was increased after verbal learning, but not after enactment (Experiment 3).

Excluded alternative explanations to the cue salience hypothesis

Given the variations in the type of action phrases that we used in the above research, we can exclude a range of alternative explanations for our finding that the enactment effect is larger for action phrases with objects as cues.

First, according to our findings, the enactment effect cannot simply be a variation of the self-reference effect (Rogers, 1981; Rogers et al., 1977) in the sense that those actions are recalled better that imply higher self involvement. Enactment effects were found for action phrases with body parts as well as for other action phrases with cues (cf. Nyberg et al., 1991, for a related finding). If the degree of self involvement was crucial for the probability of recalling action phrases, one would expect larger enactment effects only for phrases involving body parts or phrases heightening self consciousness in some other way, for instance, by being embarrassing. This pattern of findings was clearly not obtained (cf. also Perrig, 1988; Steffens, 1998). Neither proprioceptive stimulation resulting from touching body parts nor the focus on the self brought about by mentioning body parts as objects of action phrases, thus can explain the present pattern of findings.

Second, one may suspect that specific processes brought about by pretending to use specific absent objects and subsequently recalling them led to a reduction of the enactment effect. However, we also found a reduced enactment effect for the recall of verbs only.

Third, one may argue that action phrases with cues differed from action phrases without cues in that action phrases with cues more or less lent themselves to clustering along semantic categories (e.g., office-related things), whereas action phrases with absent objects did not. However, when we used action phrases with absent objects that could be clustered (Experiment 3), the resulting enactment effect was even descriptively reversed for them. As a sidenote, carrying out actions does not generally increase semantic clustering (see Steffens, 1999), and enactment effects in free recall have also been found when there was no difference in clustering between the enactment and the verbal learning condition (see Engelkamp & Zimmer, 2001, for a review). In other words, the typical enactment effect can not be explained by clustering or relational processing.

Fourth, we ruled out alternative explanations when we held constant the action phrase and manipulated whether the object was present during encoding and retrieval in our Experiment 3. The clear pattern of results that we found for these action phrases makes obvious the significant role of objects as cues in constituting the enactment effect in the present experiments.

Reconciling the present view with previous research

If there is a reduced, if not eliminated, enactment effect for actions involving absent objects, how come previous research has not indicated it? There are several reasons for that. First, in a great proportion of studies, two crucial factors were confounded. In these studies, *action phrases* were presented for verbal learning, whereas the *actual objects* involved in the performance of actions were additionally presented and manipulated by participants in the enactment condition (Bäckman & Nilsson, 1984, 1991; Bäckman, Nilsson, & Chalom, 1986; Cohen, 1981, 1983; Cohen & Bean, 1983; Cohen et al., 1987; Dick & Kean, 1989; Karlsson et al., 1989; Kormi-Nouri, 1995; Nilsson & Craik, 1990; Nilsson, Nyberg, Kormi-Nouri, & Rönnlund, 1995; Nyberg, Nilsson, & Bäckman, 1992; Nyberg & Nilsson, 1995). In analogy to the picture superiority effect (see e.g., Roediger & Weldon, 1987), an *object superiority effect* is to be expected here. The mere presentation of an object, for example a ball or a book, along with a verbal label should lead to superior memory performance as compared to a verbal learning condition in which only the word "ball" or "book" is presented (see Engelkamp & Zimmer, 1996). It is not surprising that an enactment-plus-object-presentation effect was usually found in those studies. Data that are well in line with our argument of an object superiority effect were presented by Nyberg et al. (1991). There was an 'enactment effect' in free recall when objects were, one by one, presented for use in the enactment condition, but not in the verbal learning condition (Experiment 1a). When the objects were demonstratively shown, one by one, in both conditions (Experiment 1b) there was no 'enactment effect.' Thus, the effect these authors reported in their Experiment 1a can be interpreted as a mere object superiority effect. This is consistent with our position that, in the wealth of studies cited above, enactment may or may not have improved free recall over and above the level attained by object presentation alone.

The second reason why previous research has not found a reduced enactment effect in free recall for actions involving absent objects is that, as far as one can judge from the material published, most studies have used lists consisting of both action phrases involving absent objects and action phrases with objects present (body parts, context objects). Subgroups of action phrases were not analyzed during the first years of action memory research and hardly ever thereafter (but see Cohen et al., 1987; Kormi-Nouri et al., 1994a; Kormi-Nouri, Nyberg, & Nilsson, 1994b; Norris & West, 1991; Nyberg et al., 1991). Combined analyses of all actions show the typical enactment effect, as the present experiments demonstrate.

Please note that, for clarity of presentation, we have so far pretended that there is a strict dichotomy between action phrases for which cues are present and those for which there are none. This is of course a simplification. Participants may create idiosyncratic cues, for instance, a floppy disk may cue a CD (see Discussion of Experiment 3). Moreover, body parts are always involved in carrying out actions, but we assume they are less effective cues for phrases like "throw the ball," where body parts are only implied, as opposed to "clap your hands," where body parts are explicitly mentioned. Finally, even if an experiment is described as involving absent objects only, it was probably not controlled whether for instance a sweater was present for some participants because they were wearing one, or whether an action phrase like "clean the window" was included and there was a window in the experimental room. In sum, many previous findings are hard to judge in the light of the present ones.

There are also some previous action memory findings which seem to be in conflict with the important role we ascribe to cues, but they are not. First, enactment has been found to hinder the integration of context attributes (e.g., Engelkamp & Perrig, 1986; Koriat, Ben Zur, & Druch, 1991). For instance, "in the lounge" was a superior retrieval cue if "smoke the pipe in the lounge" was imagined than if it was enacted. This finding is expected in a framework in which carrying out actions necessitates a focus on the action phrases. Thus, context attributes are well-encoded only as far as they are crucial for carrying out an action (see Steffens, 1999); in other words, if they are interactive (Baddeley, 1982). Other, independent, context attributes are largely unattended. The objects with which actions are carried out definitely belong to the interactive context factors and enactment should facilitate their integration. In short, the result that enactment hinders the integration of independent context attributes is not in conflict with the present account.

It may appear to be a second, conflicting finding that there is an enactment effect when encoding and retrieval take place in different rooms (Phillips & Kausler, 1992) or when participants close their eyes during recall (Cohen et al., 1987). Even if we assign an important role to cues, this does not imply that the enactment effect is eliminated if the context is changed between the encoding and the retrieval phase. First, as spelled out in the Introduction of the present paper, the salience and association of cues during encoding, not retrieval, is the crucial difference between enactment and other encoding conditions in the present account. Second, not only may participants mentally reinstate the study context during retrieval, but also, in the Phillips and Kausler study, the cues of half the action phrases were still present in the retrieval context because these action phrases comprised body parts. Unfortunately, subgroups of action phrases were not analyzed. Third, a context change need not eliminate the enactment effect because we are making the case for objects as cues being *one* factor contributing to the often superior free recall in an enactment condition.

Multiple determinants of memory for actions

In more than one way, our own experiments show that cues are not the only factor that determines the size of the enactment effect. First, when we showed that participants in the verbal learning condition can strategically obtain what automatically happens in the enactment condition, namely use objects as cues, the interaction of encoding condition and type of action phrase disappeared. However, an overall enactment effect remained. By implication, the processing of participants in the enactment condition was superior to that of participants in the verbal learning condition with regard to some other factor(s). Second, when we varied the encoding condition within subject (Experiment 2), we found a substantially larger enactment effect than in the other experiments (also cf. Nyberg & Nilsson, 1995). This is a typical finding in other areas of memory research, for instance, generation effects (cf. Begg & Roe, 1988; Mulligan, 2001; Schmidt, 1990; Slamecka & Katsaiti, 1987). Along with others (Steffens, 1999; Steffens & Erdfelder, 1998), these findings show that there are important similarities between memory for self-performed actions and for self-generated material. There is a third way in which our experiments show that other things besides cues determine recall. In Experiment 3, the enactment effect for body parts seems reduced as compared to the enactment effect for body parts in the previous experiments. We suspect that this, again, shows the role of list composition. When body parts were the most salient cues because there were no other cues, the enactment effect was largest for them. When a substantial number of more salient cues was present, the enactment effect for body parts was smaller; body parts may be considered less salient than other cues because the actors' focus is on the environment, not on their own person. By implication, there may well be an enactment effect for action phrases with absent objects in free recall if no objects with cues are present in the list, even in a between-subjects design. In fact, there is at least one experiment in which it is documented that all action phrases involved absent objects and in which a significant enactment effect in free recall was found (Engelkamp & Zimmer, 1996). That and other findings—for instance, enactment effects in recognition tests—show that the presence of objects as cues is not the only factor on which action memory performance depends. Enactment also brings about item-specific elaboration of the verb and object as well as verb–object unitization. Future research will determine whether cues increase the enactment effect for some phrases, suppress that effect for other phrases, or do both.

To explain superior recall after enactment, a motor memory code has been postulated (Engelkamp, 1998; Engelkamp & Zimmer, 1994). One may assume that according to this view, the enactment effect should be larger for those phrases that require more movements. However, it has proven very difficult to change the size of the enactment effect by such variations as the elaborateness with which actions are carried out (Nilsson & Cohen, 1988; Nilsson et al., 1995). Further, the specific movement has been shown to play a minor role for the probability of remembering a given action phrase (e.g., Engelkamp & Zimmer, 1995; Knopf & Neidhardt, 1989). We thus took no precautions to control for the amount of motor information that a specific type of action phrase supplied, except for avoiding tactile contact with the objects in Experiment 3 by putting them just out of reach. We therefore cannot see how carrying out the same action phrases could have provided significantly more motor information if the objects are present than if they are not. If carrying out actions had supplied a motor code which increased recall probability, an enactment effect should have emerged both for action phrases involving present objects and for those involving absent objects. Thus, the present pattern of data is not easily explained with a memory-relevant motor code. We currently see no way to empirically falsify the assumption that a motor code, in interaction with other factors, plays some role in remembering actions. However, fine-grained analyses that show different-size enactment effects for different types of action phrases (or different list parts, see below) make a general motor code become less likely or less important.

As has recently been suggested, pop-out into memory is a phenomenon enhanced if actions have been performed (Zimmer et al., 2000). As the term illustrates, a proportion of the items seem to be remembered spontaneously. This proportion seems to be increased after enactment. Zimmer et al. speculate that the activated features of the concepts are bound together during encoding and form an engram. If this engram is sufficiently active, it spontaneously pops out. Possibly, pop-out is guided by retrieval cues such as those investigated here—not necessarily accompanied by participants' awareness concerning the path to remembering a given action. In line with this and other recent analyses of memory for actions (e.g., Nilsson, 2000), but in contrast to early action memory research (Cohen, 1981), our findings strengthen the notion that differences between memory for actions and for verbal materials are quantitative, rather than qualitative, in nature.

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Appendix A. Action phrases with body parts

Experiment 1a

die Nase kratzen (scratch your nose), die Augen reiben (rub your eyes), in die Wange kneifen (pinch your cheek), in die Hände klatschen (clap your hands), die Haare kämmen (comb your hair), den Kopf schütteln (shake your head), die Zähne putzen (brush your teeth), das Gesicht eincremen (put creme on your face), mit den Fingern schnipsen (snap your fingers).

Experiment 1b

auf die Schenkel klopfen (pat your thighs), die Augen zuhalten (cover your eyes), die Beine strecken (stretch out your legs), den Hals umgreifen (put your hands around your throat), das Ohrläppchen drücken (squeeze your ear lob), die Nase rümpfen (wrinkle your nose), das Kinn kratzen (scratch your chin), die Knie anheben (lift your knees), die Zunge rausstrecken (stick out your tongue), die Hände falten (fold your hands), die Lippen nachmalen (refresh your lipstick), die Füße kreisen (draw circles in the air with your feet), über die Schulter gucken (look over your shoulder), mit dem Kopf nicken (nod), in die Hüfte kneifen (pinch your hip), durch die Haare streichen (move your fingers through your hair), den Bauch tätscheln (pat your tummy).

Experiment 2

den Arm hochheben (lift your arm), mit den Fingern schnippen (snap your fingers), an den Haaren ziehen (pull your hair), das Kinn kraulen (rub your chin), den Kopf schütteln (shake your head), die Augen reiben (rub your eyes), den Bauch tätscheln (pat your tummy), das Bein strecken (straighten your leg), die Hände falten (fold your hands), an das Ohr fassen (touch your ear).

Experiment 3

auf die Schulter klopfen (pat your shoulder), mit den Fingern schnippen (snap your fingers), den Kopf schütteln (shake your head), die Augen reiben (rub your eyes), über den Bauch streichen (stroke your tummy), das Bein strecken (straighten your leg), die Hände falten (fold your hands).

Action phrases with absent objects

Experiment 1a

den Hut aufsetzen (put on the hat), die Geige spielen (play the violin), das Lasso werfen (throw the lasso), die Jacke anziehen (put on the jacket), auf den Stuhl klopfen (knock on the chair), auf den Boden stampfen (stomp on the floor), den Sicherheitsgurt anlegen (put on the seat belt), aus dem Glas trinken (drink out of the glass), in dem Buch blättern (leaf through the book), das Brot schmieren (prepare a sandwich), die Kerze ausblasen (blow out the candle), das Hemd zusammenlegen (fold the shirt), den Ast absägen (saw off the branch), die Flasche entkorken (uncork the bottle), die Wäsche aufhängen (hang up the wash), den Umschlag frankieren (put the stamp on the envelope), die Zigarette anzünden (light the cigarette), den Zaun streichen (paint the fence), die Hose bügeln (iron the trousers), das Pferd reiten (ride the horse), die Fahne schwenken (wave the flag), das Orchester dirigieren (conduct the orchestra), den Regenschirm öffnen (open the umbrella), die Banane schälen (peel the banana), die Bälle jonglieren (juggle with the balls), den Stock durchbrechen (break the stick).

Experiment 1b

die Blumen gießen (water the flowers), den Pfeil abschießen (shoot the arrow), die Schublade öffnen (open the drawer), den Bleistift anspitzen (sharpen the pencil), die Uhr stellen (set the clock), den Hund streicheln (pet the dog), den Stecker rausziehen (unplug the plug), den Brei umrühren (stir the porridge), das Paket aufreißen (tear open the parcel), auf dem Klavier spielen (play the piano), den Brotteig kneten (knead the dough), das Auto lenken (drive the car), das Fenster schließen (close the window), die Vorhänge aufhängen (hang up the curtains), die Plätzchen ausstechen (cut out the cookies), den Teppich ausklopfen (beat the carpet), den Spiegel putzen (clean the mirror).

Experiment 2

den Ast absägen (saw off the branch), mit Bällen jonglieren (juggle with the balls), das Brot schmieren (butter the bread), das Kissen ausschütteln (fluff up the pillow), das Paket aufreißen (tear open the parcel), Geige spielen (play the violin), das Hemd zusammenlegen (fold the shirt), den Nagel einschlagen (pound in the nail), den Sicherheitsgurt anlegen (put on the seatbelt), den Stock durchbrechen (break the stick).

Experiment 3

das Brot schmieren (prepare a sandwich), die Flasche entkorken (uncork the bottle), die Banane schälen (peel the banana), den Brei umrühren (stir the porridge), die Plätzchen ausstechen (cut out the cookies), die Möhre essen (eat the carrot), den Saft trinken (drink the juice).

Action phrases consisting of verbs only (Experiment 2)

blättern (leaf), rühren (mix), winken (wave), zappeln (fidget), zudrücken (push closed), gähnen (yawn), graben (dig), lenken (steer), schneiden (cut), verknoten (knot).

Action phrases with objects in the experimental context

Experiment 2

auf den Boden stampfen (stomp on the floor), in die Luft zeichnen (draw in the air), die Maus bewegen (move the mouse), mit dem Stuhl schaukeln (rock on your chair), die Trennwand kratzen (scrape the partition), dem Bild zunicken (nod at the picture), den Computer berühren (touch the computer), aus dem Fenster schauen (look out the window), auf den Tisch klopfen (knock on the table), auf die Tür zeigen (point to the door).

Experiment 3

auf die Türe zeigen (point to the door), an die Decke schauen (look at the ceiling), auf den Tisch klopfen (knock on the table), die Trennwand berühren (touch the partition), den Schrank öffnen (open the cabinet), auf den Boden stampfen (stomp on the floor).

Action phrases where the presence of objects was manipulated (Experiment 3)

den Bildschirm einschalten (turn on the computer screen), das Mousepad säubern (clean the mouse pad), das Blatt zerknüllen (wad up the piece of paper), die Schreibtischlampe heranziehen (pull the desk light towards you), den Kopfhörer aufsetzen (put on the earphones), den Kaffeebecher ausspülen (wash out the coffee mug), den Papierkorb umstoßen (knock over the waste paper basket), die Diskette einschieben (put in the floppy disk), die Schreibunterlage abwischen (wipe off the blotting pad), den Bleistift anspitzen (sharpen the pencil), das Bild gerade rücken (straighten the picture), das Mikrophon einstöpseln (plug in the microphone), die Uhr stellen (set the clock), den Pappkarton treten (kick the cardboard box), die CD einlegen (put in the CD).

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