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Gains and losses in action memory

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Enacting action phrases (SPT for subject-performed task) produces better free recall than only learning the phrases verbally (VT for verbal task). A widespread explanation of the enactment effect is based on the distinction between item-specific and relational information. There is widespread agreement that the main reason is the excellent item-specific encoding by enactment. However, there is little direct evidence in the case of free recall. The role of relational information is less clear. We suggest that content-based relational encoding is better in VTs than in SPTs. In three experiments, in which multiple free recall testing used item gains and losses as indices of item-specific and content-based relational encoding, respectively, these assumptions were confirmed. Consistently more gains (indexing better item-specific encoding) and more losses (indexing poorer relational encoding) were observed in SPTs than in VTs (Experiments 1 and 2). Furthermore, it was demonstrated that the content-based relational information underlying losses is not identical with order-relational information (Experiment 2). In Experiment 3, it was shown that an item-specific orienting task for VTs produced an equivalent number of item gains and losses as did the SPT condition.

Item-specific and relational information and multiple recall testing

The distinction between item-specific and relational information has proved to be an important and valuable distinction in research on remembering (e.g., Hunt & McDaniel, 1993; Marschark, Richman, Yuille, & Hunt, 1987; McDaniel, Einstein, Dunay, & Cobb, 1986). Item-specific information refers to the information is characteristic for each individual item. Relational information refers to interitem relations. These two concepts have been used successfully to explain such different memory phenomena as the bizarreness effect (e.g., McDaniel, Einstein, DeLosh, May, & Brady, 1995), the generation effect (McDaniel, Waddill, & Einstein, 1988; Steffens & Erdfelder, 1998), and the perceptual interference effect (e.g., Mulligan, 1999) as well as to explain the differences in performance observed for free recall and recognition memory (e.g., Einstein & Hunt, 1980; Hunt & Einstein, 1981), directed

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forgetting (e.g., Basden, Basden, & Gargano, 1993), or design effects in recall (e.g., Engelkamp & Zimmer, 1997; Serra & Nairne, 1993).

However, measuring item-specific and relational information in free recall was indirect because both components contribute commonly to recall performance. The general procedure was to enhance item-specific and/or relational information relative to some control by corresponding orienting tasks. Free recall was expected to increase if either item-specific or relational information or both were increased. A direct measurement of relational information was only possible by some organizational score if the learning list was categorically structured (e.g., Engelkamp & Zimmer, 1996; Hunt & Einstein, 1981; McDaniel et al., 1986). However, the level of organizational performance in free recall did not provide direct information about item-specific information in free recall. Item-specific information was assessed in recognition memory tests. The results of these measurements were then generalized to free recall (e.g., Engelkamp & Zimmer, 1996; Hunt & Einstein, 1981). Hence, measurement of relational information in free recall was restricted to categorically related lists, and measurement of item-specific information was restricted to tests of recognition memory.

This situation changed in the late 1980s when the distinction of item-specific and relational information was applied to the study of hypermnesia by Klein, Loftus, Kihlstrom, and Aseron (1989). In multiple recall studies, it is often observed that performance in free recall increases with multiple testing. This phenomenon is called hypermnesia. Hypermnesia is observed when during the recall trials it occurs more often that new items are remembered in a test trial that have not been remembered in the preceding trial (item gains) than that items are forgotten from one test trial to the next (item losses).

Klein et al. (1989) manipulated item-specific and relational encoding during study. They demonstrated that encoding providing item-specific information produced hypermnesia by facilitating recovery of new items over trials—that is, by increasing the number of item gains, whereas encoding providing relational information produced hypermnesia by preventing the loss of previously recalled items—that is, by decreasing the number of item losses. Burns (1993), Burns and Gold (1999), and McDaniel, Moore, and Whiteman (1998) replicated the Klein et al. (1989) results and provided evidence that item gains and losses can be used to index the amount of item-specific and relational processing in a variety of experimental contexts.

There is widespread agreement that conditions that foster relational encoding (i.e., encoding of interrelations among the items) protect against the forgetting of items. This claim is grounded in the theoretical idea that relational information encoded during study is used during test as a retrieval plan to generate the particular items considered as targets (e.g., Burns, 1993; Hunt & McDaniel, 1993; McDaniel et al., 1998). The retrieval plan that leads to the generation of a particular item in one test trial will do so again in a subsequent trial, and thereby item forgetting is reduced. Without relational information, such consistent retrieval plans would not easily develop, but rather the internally generated retrieval cues would vary from one recall trial to the next. An item that would be generated in one trial would not necessarily be generated in the next in this case. That is, without a consistent retrieval plan, forgetting would be more likely (e.g., Burns, 1993; Klein et al., 1989; McDaniel et al., 1998).

A theoretical argument why enhancing item-specific encoding consistently leads to more item gains (e.g., Burns, 1993; Klein et al., 1989) is given by McDaniel et al. (1998). McDaniel et al. (1998) suggest that focusing attention on individual items produces a richer and more extensive set of features, which are encoded about each item. They assumed that an item would be recalled if some minimal number of features, is recovered. Therefore, an item with many encoded features that is not recovered in one trial has a good chance that in the next trial a critical number of features will be recovered. That means items that are encoded more richly will produce more item gains than those with a less extensive set of features encoded (cf., Craik & Tulving, 1975; McDaniel et al., 1998, p. 175; Nairne, Pusen, & Widener, 1985).

A further important assumption of McDaniel et al. (1998) is that good item-specific encoding does not necessarily mean that it reduces the likelihood of a stable and consistent retrieval plan provided through relational information and, vice versa, that good item-specific encoding makes retrieval cues more effective no matter which way the retrieval cues are generated. Particularly the latter assumption shows that it is necessary to analyse both item gains and losses in order to learn about the underlying item-specific and relational encoding processes and their contribution to recall.

Altogether, there is ample evidence showing that the number of item gains depends on the amount of item-specific encoding and that the number of item losses is a function of relational encoding (e.g., Burns, 1993; Burns & Gold, 1999; Klein et al., 1989; McDaniel et al., 1998; Mulligan, 1999). Therefore, it seems justified to consider the number of gains and losses as indicators of the amount of item-specific and relational information that is provided by a specific encoding task. Mulligan (2001) has recently applied this logic to contribute to clarifying the processes underlying the generation effect. In the present study, gains and losses will be used to clarify the role of item and particularly relational information in action memory.

Item-specific and relational information in action memory

In studies of action memory, lists of action phrases such as “open the umbrella” or “squeeze the sponge” are usually learned under two conditions. In a verbal task (VT), participants just memorize the phrases. In a subject-performed task (SPT), participants additionally perform the actions. In most experiments, they do so without using real objects. A robust SPT effect is consistently observed in recall as well as in recognition tests (see Engelkamp, 1998; Nilsson, 2000; Zimmer, 2001, for reviews). This effect is usually explained by claiming that SPTs provide better item-specific information than do VTs (e.g., Engelkamp, 1988; Helstrup, 1986; Knopf, 1991; Mohr, Engelkamp, & Zimmer, 1989). However, the empirical evidence in free recall has been indirect until now. It is based on the finding that recognition memory is better in SPTs than in VTs. Therefore it is assumed that recognition memory primarily indicates item-specific information and that it is the same item-specific information that is used in free recall (e.g., Mohr et al., 1989).

Other studies concluded that SPTs provide good item-specific information from the observation that performance in free recall varies little for SPTs if the level of processing is manipulated (e.g., Nilsson & Craik, 1990; Zimmer & Engelkamp, 1999). It is assumed that the item-specific encoding in SPTs compared with VTs is basically very good and that no room is left to increase it further. Similarly, no generation effect was observed for SPTs (e.g., Nilsson & Cohen, 1988). The conclusion is that generation increases item-specific information, and because item-specific information provided by enactment is already good, it is difficult to increase it further.

From the findings that levels of processing and generation influence verbal learning, but have little influence on learning by enactment, it is inferred that item-specific encoding in

SPTs is good by the very nature of the accompanying encoding processes and better than in VTs as long as no explicit task reinforces encoding on item information.

In other studies in which related lists were used, it was observed that categorical clustering did not differ between VTs and SPTs, but that an SPT effect could nevertheless be observed in free recall (e.g., Engelkamp & Zimmer, 1996). From this finding it was concluded that item-specific information must be decisive for the SPT effect because relational information does not differ. However, there were other studies (e.g., Bäckman, Nilsson, & Chalom, 1986) that observed different amounts of categorical clustering for VTs and SPTs so that no firm conclusions could be drawn. Moreover, such evidence would be confined to related lists.

Altogether, the evidence that SPTs provide better item-specific information than do VTs is rather indirect, and more direct evidence would be desirable. Studying the number of gains in the multiple testing paradigm offers the possibility for such a direct test.

There is less agreement in regards to the role of relational information, and most of the discussion was focused on categorically structured lists. Hence, the findings are confined to clustering scores, and they are as inconsistent as the theoretical positions (e.g., Bäckman et al., 1986; Engelkamp & Zimmer, 1996; Zimmer & Engelkamp, 1989).

The focus here is on unrelated lists as the more general case. Unrelated lists have rarely been studied before under the perspective of differential use of relational information in VTs and SPTs, presumably because there was no convincing score to measure relational encoding with unrelated lists. In our opinion, there is an essential difference between processing of items of related and unrelated lists. Related lists refer to interindividually shared long-term knowledge structures such as episodes or taxonomies. It seems likely that items of related lists automatically prime other items from the same category via spreading activation (e.g., Fischler & Goodman, 1978; Meyer & Schvaneveldt, 1971). Thus, they are probably automatically relationally encoded even though the automatic encoding may be completed by controlled encoding processes (e.g., Neely, 1977). In contrast, items of unrelated lists do not refer to such well established interindividually shared knowledge structures. In order to encode them relationally, participants must actively search for idiosyncratic associations. For instance, if "put on the hat" and "open the umbrella" are presented, these two items may be relationally encoded by thinking of leaving the house on a rainy day. We refer to such relational encoding as content-based relational encoding because these encoding processes are induced by the specific item contents. The items that are associated in such a way do not necessarily have to occur as neighbours on the study list.

We assume that such idiosyncratic content-based relational encoding processes are easier in VTs than in SPTs because enacting actions focuses attention on the processing of the individual items and distracts it from interitem associations. Listening to or reading an action phrase (e.g., "put on the hat") and enacting it forces the participants to understand the command and to perform it, and to do the same when the next item follows (e.g., "open the umbrella"). Only listening to or reading the phrases, in contrast, does constrain the encoding processes less and encourages or, at least, allows one to also focus on semantic relations among the items (Engelkamp, 1995).

The multiple testing paradigm also allows for the testing of this assumption. It was therefore a main goal of the present study to demonstrate that the better item-specific encoding of SPTs than of VTs is reflected in a greater number of item gains in SPTs than in VTs and that the better relational encoding of VTs than of SPTs is reflected in a smaller number of item losses in VTs than in SPTs.

The distinction between content-based and order-based relational information

There is some evidence that unrelated action phrases are more difficult to relate if the denoted actions are performed than if they are only listened to or imaginally encoded. This evidence stems from paired-associate learning (PAL) experiments. In these experiments, participants learned 12 unrelated action–verb pairs. In this paradigm, it was observed that unrelated action verbs were particularly poorly recalled for SPTs if a cued recall test was used (e.g., Engelkamp, 1986; Engelkamp, Mohr, & Zimmer, 1991). In order to explain this poor cued recall of SPTs, it was suggested that enactment focuses attention on single-item processing and thereby hinders pair integration. However, the PAL paradigm has specific features that render the interpretation of cued recall ambiguous. The poor cued recall of SPTs might be due to two kinds of relational encoding difficulty. It might be assumed that content-based relational encoding is difficult with SPTs, but also that order-based (content-free) relational encoding is difficult with SPTs. It is difficult to decide between both explanations because cued recall not only requires that unrelated items are relationally encoded, but moreover in cued recall a target item must be found from its partner item in a pair—that is, two particular items must be related for no other reason than that they are neighbours of a pair (not due to any item content). Therefore, we speak of order-relational information. The fact that in the PAL experiments there is also the typical SPT effect in free recall (Engelkamp et al., 1991) does not help us to come to a clearer conclusion because it remains unclear whether this effect is due to better item-specific or relational information of SPTs than of VTs.

However, there is some evidence from another paradigm that order-based relational encoding is poor in SPTs. Order-based relational encoding was repeatedly studied with short lists of six or eight unrelated items. In such studies, order-based relational encoding is usually measured by an order reconstruction test. In such a task, the items are presented at test in a random order, and it is the task of the participants to assign the items to their order at presentation (e.g., DeLosh & McDaniel, 1996; Mulligan, 1999; Serra & Nairne, 1993). Engelkamp and Dehn (2000) studied action phrases within this paradigm. They demonstrated that order encoding was better if the participants observed how the experimenter performed the actions than if they performed the actions themselves. However, this finding was only observed as long as the type of task was a between-subjects factor. If the type of encoding was measured within-subjects in one list, the disadvantage in order reconstruction in SPTs disappeared. Order reconstruction no longer differed between encoding tasks. A corresponding finding was observed in other studies using other encoding tasks (e.g., DeLosh & McDaniel, 1996; Mulligan, 1999; Serra & Nairne, 1993). This finding is generally explained by assuming that the continuous shift between the encoding conditions impairs order encoding of that condition which provides better order information in a between design (e.g., DeLosh & McDaniel, 1996; Serra & Nairne, 1993).

This point was discussed at some length because we assume that content-based relational encoding operates independently of the type of design for the encoding tasks. Content-based encoding is localized on a higher processing level and should be relatively independent of physical conditions such as presentation order. Hence, we assume for unrelated lists that SPTs provide poorer content-based relational encoding than do VTs. This disadvantage of SPTs should be independent of the type of design for the encoding factor. This latter attribute distinguishes content-based relational encoding from order-based relational encoding, which is dependent on the type of design.

Therefore, it was a second goal of this study to test whether better relational information of VTs than of SPTs, as indicated by the smaller number of item losses in VTs than in SPTs, can also be observed in a within-subjects design for type of encoding. If this were the case, we would conclude that order-based relational information is not reflected in the number of item losses in multiple testing.

Increasing item-specific encoding in VTs makes VTs similar to SPTs

A last goal of the present study was to validate the interpretation of the number of gains and losses as indices of item-specific and relational information in action phrases. If the assumption is correct that enactment directs attention to processing the single items and hence distracts attention from processing relations among the items, then a similar pattern of gains and losses as that for SPTs should be observed for VTs if in VTs participants are given an orienting task that directs their attention to single-item processing and distracts it from relational encoding. Under such conditions, the number of gains and losses in VTs should be increased compared with standard VTs.

Overview of the experiments

In the present experiments, we therefore use gains and losses in multiple recall testing as an alternative approach for assessing the role of item-specific and relational information in the enactment effect. The advantage of this approach is that it measures item-specific *and* relational information in recall and that it does so directly from recall performance. In the other approaches item-specific information in recall was assessed indirectly from performance in recognition memory tests. Moreover, it allows one to measure relational information in recall of related and unrelated lists (cf., Mulligan, 2001).

To our knowledge, there is only one study in which action phrases had been studied before in the multiple testing paradigm. Olofsson (1997) presented a list of 40 action phrases in VTs and SPTs and tested recall in three trials. Using the number of intertest gains and intertest losses as indices of item-specific and relational information, Olofsson provided evidence that action phrases that are symbolically enacted during study led to more gains than losses (i.e., showing hypermnesia), whereas gains and losses did not differ for action phrases encoded in VTs. Moreover, there were more gains and more losses in SPTs than in VTs, indicating better item-specific and worse relational encoding in SPTs than in VTs.

However, with regard to evaluating explanations of the enactment effect by the componential analyses of multiple testing, a single experiment is clearly insufficient. A first goal of the present study was therefore to investigate whether we could replicate the results reported by Olofsson (1997). In order to yield more generalizable results, we used three different lists and five recall test trials in Experiment 1. In addition, we counted correct phrase recall instead of only counting the correct recall of the nouns as did Olofsson.

In Experiment 2, we used a within-subjects design for type of encoding instead of a between-subjects design. This experiment served to generalize the finding across design type and thereby to demonstrate that losses do not reflect order-based relational encoding processes.

In Experiment 3, we only used VTs and manipulated the degree of item-specific encoding by comparing standard VTs with VTs in which the participants were pushed to focus on item-specific information by a corresponding orienting task. This experiment served to demonstrate that pushing item-specific encoding in VTs makes the pattern of findings similar to that of SPTs, thereby validating the assumption of SPT encoding.

EXPERIMENT 1

In Experiment 1 we contrasted two conditions: one in which participants encoded several action phrases by attentive reading (VT) and the other in which subjects had to perform the actions (SPT), both in unrelated lists. We assumed that SPTs provide more item-specific information than do VTs, which should result in more item gains in a multiple testing for SPTs than for VTs. In contrast in VTs, we expected a more active encoding of content-based relational information than in SPTs. This should result in reduced item-losses compared to SPTs.

Method

Participants

A total of 42 students at the Saarland University participated in the experiment. They were paid for their participation. Of the 42 participants, 21 were randomly assigned to the VT condition and the remaining 21 to the SPT condition.

Material

The material consisted of three lists with 42 action phrases. The phrases described everyday actions that were unrelated, like, “set the table” or “light the match”. To control the distribution of the items over the list positions, each participant was presented one of the three learning lists in a different order. For this purpose, the phrases were moved through the list in blocks of six items.

Procedure

In this experiment each participant was tested individually. The participants were instructed to learn a list of action phrases for a later memory test. Half of the participants were requested to learn the presented action phrases by attentive reading (VT), and the other half were directed to learn the phrases by performing the actions symbolically (SPT). The action phrases were shown one after the other on a computer screen. Each phrase was preceded by a warning tone and displayed for 5 s. After an interval of 500 ms, the next phrase appeared on the screen. After learning the phrases, participants were requested to write down all phrases they could remember in 4 min. This was followed by another four successive free recalls.

Results

Since participants studied three different learning lists it must be examined whether the lists make differential effects on the results. Since there were no different impacts, the data were combined in the following analyses.

The data of the recall tests are presented in Table 1. The 2 x 5 analysis of variance (ANOVA) yielded a significant enactment effect, $F(1, 40) = 28.05$, $MSE = 0.0574$, $p < .000$. Recall of SPTs (.39) was better than of VTs (.22) There was also a recall test effect, $F(4, 160) = 6.13$, $MSE = 0.0011$, $p < .000$. Recall performance increased over trials. The interaction of type of encoding and recall test approached significance, $F(4, 160) = 2.01$, $MSE = 0.0011$, $p < .10$. Separate analyses for VTs and SPTs yielded the following effects. The test effect for SPTs was significant, $F(4, 80) = 6.41$, $MSE = 0.0012$, $p < .001$. However, for VTs it was not ($F < 1$).

The data for the recall components are depicted in Table 2. There were more item gains after SPTs (7.67) than after VTs (3.00), $F(1, 40) = 18.34$, $MSE = 3.1167$, $p < .000$, and gains decreased over recall tests, $F(3, 120) = 2.76$, $MSE = 1.7413$, $p < .05$. The interaction was not significant, $F(3, 120) = 1.17$.

The analysis of losses yielded a significant effect of type of encoding, $F(1, 40) = 15.21$, $MSE = 1.5530$, $p < .001$. SPTs (5.48) produced more losses than VTs (2.48). Losses decreased over test trials, $F(3, 120) = 6.61$, $MSE = 0.8704$, $p < .001$. Both factors interacted, $F(3, 120) = 2.89$, $MSE = 0.8704$, $p < .05$, due to irregular values over test trials in SPTs.[1]

Discussion

The free recall performances showed a clear enactment effect over all recall tests, and the recall performance increased over trials. Thus, hypermnesia occurred. However, the interaction

[1]It might be objected that the specific pattern observed for gains and losses results from a subset of the items that show an unstable recall pattern across test trials and that contribute accidentally to the observed pattern. For instance, the hypermnesia effect could appear to be larger than it actually is. In order to refute the argument that the effects observed in our study are inflated due to item instability, we added a data analysis that excludes unstable items that oscillate between recall and nonrecall across recall trials. In other words, we included only those items in our analysis of gains that were not remembered in the first recall, but were recalled systematically from some later recall, and those that were recalled consistently after they were once forgotten, but then systematically recalled. Correspondingly, losses were analysed only of those items that were forgotten after the first or after some later recall trial and those items that were forgotten consistently after they were one time gained. It should be noted that the latter items were very few (0.1 item out of 42) and did not influence the results of the analyses. This procedure resulted in the following number of gains and losses in VTs and SPTs of Experiment 1:

	VT	SPT
Number of		
gains	1.7	4.4
losses	1.2	2.3

An ANOVA including the factors encoding task (VT, SPT) and number of item gains and item losses yielded a significant enactment effect, $F(1, 40) = 18.87$, $MSE = 3.8381$, $p < .001$. There were more gains and losses after SPTs than after VTs. Furthermore, there were more gains than losses, $F(1, 40) = 11.62$, $MSE = 2.9881$, $p < .01$, documenting a clear hypermnesia effect also if all instable oscillating items were excluded. (Experiments 2 and 3 showed corresponding results.) Hence, the analysis shows that our findings are not due to a subset of items that accidentally oscillate between recall and nonrecall across trials.

TABLE 1
Mean proportion recalled as a function of recall test and encoding condition

		Recall test					
Experiment	*Task*	*1*	*2*	*3*	*4*	*5*	*Mean*
1	VT	.21	.21	.21	.22	.22	.22
	SPT	.37	.38	.39	.40	.42	.39
2[a]	VT	.19	.19	.21	.21	.23	.21
	SPT	.41	.41	.44	.43	.45	.43
3	VT	.34	.33	.34	.35	.36	.34
	VT + rating	.39	.39	.41	.42	.44	.41

Note: VT = verbal task; SPT = subject-performed task.
[a]Within-list design.

TABLE 2
Mean number of item gains and item losses as a function of recall test and encoding condition

			Between tests				
Experiment		*Task*	*1–2*	*2–3*	*3–4*	*4–5*	*Total*
1	Gains	VT	1.05	0.86	0.76	0.33	3.00
		SPT	2.62	1.62	1.57	1.86	7.67
	Losses	VT	1.00	0.81	0.33	0.33	2.48
		SPT	2.05	0.90	1.52	1.00	5.48
2[a]	Gains	VT	0.67	0.47	0.53	0.53	2.20
		SPT	0.67	1.20	0.67	0.93	3.47
	Losses	VT	0.73	0.13	0.40	0.13	1.40
		SPT	0.60	0.47	0.87	0.53	2.47
3	Gains	VT	1.60	1.20	1.00	0.87	4.67
		VT + rating	2.20	2.13	1.80	2.00	8.13
	Losses	VT	1.73	0.93	0.60	0.53	3.80
		VT + rating	2.33	1.47	1.27	1.07	6.13

Note: VT = verbal task; SPT = subject-performed task.
[a]Within-list design.

indicated that hypermnesia was due to SPTs. The hypermnesia effects were as to be expected on the basis of the literature (e.g., Erdelyi & Becker, 1974; Payne, 1986, 1987, for an overview). There was hypermnesia in the nonverbal, subject-performed condition, but not in the verbal encoding condition.

For gains, there was an SPT advantage over VTs and, more important, there were also more losses for SPTs than for VTs suggesting that item-specific encoding was better in SPTs and relational encoding better in VTs.

The number of gains and losses decreased over trials for VTs and for SPTs. The finding that losses decreased over trials is to be expected if output strategies are becoming more stable over trials. The finding that the number of gains decreases over trials is to be expected if items that have been recalled are likely to be recalled again so that the pool of items from which gains are acquired becomes smaller over trials.

On the basis of Experiment 1 and on the findings of Olofsson (1997) we can summarize the following: There is clearly better item-specific information with SPTs than with VTs. This fact is reflected in a larger number of item gains in SPTs than in VTs. More important, because this has hardly been noticed before, VTs provide better relational information—that is, they produce less item losses than SPTs in unrelated lists. We attribute this latter effect to the fact that participants make more use of active content-based relational encoding and that they retrieve the items more strategically in recall of VTs than of SPTs. However, this advantage of VTs in relational encoding cannot compensate for their poorer item-specific encoding compared with SPTs as is reflected in the consistent SPT effect in free recall.

EXPERIMENT 2

As mentioned, Experiment 2 served to test whether the findings from studying VTs and SPTs in a between-subjects design can be generalized to a within-subjects design. In many SPT studies, within-subjects designs were used (e.g., Ecker & Engelkamp, 1995; Engelkamp, 1997; Engelkamp & Zimmer, 1997; Nilsson, Cohen, & Nyberg, 1989; Nyberg & Nilsson, 1995; see Engelkamp, 1998, for a review). Also, in within-subjects designs a robust SPT effect can be observed. Furthermore, if also in a within-subjects design more losses will be observed in SPTs than in VTs, such a finding speaks against the assumption that the underlying relational information is based on order encoding.

The critical point is that order information is conceived of as a type of interitem relational information (e.g., Mulligan, 2001) and that it is assumed that generation and enactment attract greater item processing at the expense of order encoding, or, more generally, of interitem relational encoding. The complementary conditions should show the reversed pattern. They attract greater order encoding and less item encoding. An important additional assumption of the item-order hypothesis is that these assumptions are confined to between manipulations of generation and enactment. Thus, for between manipulations of encoding, the item-order hypothesis predicts both more gains and more losses for enactment than for verbal learning. The order- and the content-based accounts make the same predictions for this case.

However, the predictions diverge if within-subject manipulations of type of encoding are considered. According to the item-order hypothesis, it is assumed that in a within-subject design the contiguity of SPTs and VTs during list presentation leads to an interaction in the way that SPTs influence and disturb the order encoding of VTs (e.g., Burns, Curti, & Lavin, 1993; DeLosh & McDaniel, 1996; Serra & Nairne, 1993). Thus, the item-order hypothesis suggests that in a within-subjects design SPTs still enhance item-specific encoding, but that it not only disrupts relational encoding of other SPT items but also of VT items. Thus, for mixed lists more item gains are predicted for SPTs than for VTs as before, but in contrast to before, differences in item losses are no longer predicted.

The predictions from the content-based account of relational encoding are different. From this perspective, relational encoding consists in the use of idiosyncratic long-term knowledge structure; this use should not essentially suffer from a within-subjects design. One would still expect fewer losses in VTs than in to SPTs. Experiment 2 served to test these alternative hypotheses.

Method

Participants

The participants were 15 students of the Saarland University. The study was included in a seminar for psychology students. They were randomly assigned to two groups, which were tested separately and only differed in the sequence of encoding conditions.

Material

One of the three lists of Experiment 1 was selected at random to act as the actual learning list. It consisted of 42 action phrases. Since the subjects had to study the list under a mixed encoding condition, which means that they had to encode some of the items under SPT and the others under VT, two versions of this list were created. For the first variant of the list each phrase was linked to one of the two encoding conditions. A fixed sequence of SPTs and VTs was stated, whereby not more than two successive phrases were linked to the same encoding condition. The second version of the learning list consisted of the same phrases in the same order. Only the type of encoding for each item was inverted. A phrase that had to be encoded under VT in the first version had to be encoded under SPT in the second and vice versa.

Procedure

The procedure was generally similar to that of Experiment 1. However, the phrases were presented acoustically instead of visually. The participants were split into two groups, and the groups were tested separately. Each subject received a booklet with the instruction and response sheets. Participants were requested to study a list with action phrases, some phrases under VT and some under SPT for a later memory test. Before reading the action phrase the experimenter announced the kind of encoding condition by saying "perform" for SPT and "listen" for VT. Phrases were presented with an interstimulus interval of 6 s. During the study phase, all subjects had to close their eyes. After learning the phrases subjects turned the page in their booklets to a blank sheet of paper and were instructed to write down all phrases they could remember in any order. If they were unable to recall the whole phrase, they had to write down the remembered part. The time given for completing the recall test was set to 4 min. When the time had elapsed, subjects turned the page and found a second response sheet again with the instruction to write down all phrases they could remember. Afterwards free recall was repeated another three times for the same material, giving an overall total of five free recalls.

Results

The data of the recall tests are presented in Table 1.

The data of both experimental groups were collapsed. An ANOVA for free recall in a 2 × 5 design with the factors encoding condition and recall test yielded a clear-cut SPT effect, $F(1, 14) = 97.98$, $MSE = 0.0190$, $p < .000$. Recall was better after SPTs (.43) than after VTs (.21). Recall increased over test trials, $F(4, 56) = 4.74$, $MSE = 0.0021$, $p < .001$. Both factors did not interact ($F < 1$).

An ANOVA for gains approached significance, $F(1, 14) = 4.06$, $MSE = 0.7405$, $p = .06$. There were more gains in SPTs (3.47) than in VTs (2.20). However, recall test ($F < 1$) and the interaction of both factors ($F = 1.5$) were not significant.

In an ANOVA for losses, the effect of type of encoding was significant, $F(1, 14) = 6.14$, $MSE = 0.3476$, $p < .05$. There were more losses after SPTs (2.47) than after VTs (1.40). The factor recall test, $F(3, 42) = 1.8$, $p = .16$, and the interaction of both factors ($F = 1.04$) were not significant.

Discussion

As expected, there was also a SPT effect in free recall in the within-subjects design. Furthermore, there was hypermnesia for both encoding conditions. These free recall findings were confirmed by the componential analyses. More gains were observed in SPTs than in VTs. Importantly, a higher number of losses after SPTs than after VTs was also observed as in the previous experiments. The findings of the losses support the assumption that content-based relational encoding is also better in VTs than in SPTs in a within-subjects design. This finding is not in line with the assumption of the item-order hypothesis that relational information of VTs is reduced to the level of that of SPTs in a within-subjects design.

This finding makes clear that order-based interitem associations (order-relational information) must be distinguished from content-based interitem associations (conceptual-relational information). Losses do not indicate order-relational information in this experiment.

Mulligan (2001) applied a similar logic using the generation paradigm. He observed in contrast with our finding an equal number of losses for generate and read items in a within-subjects design. However, one must take into account that the generation task is not in all respects similar to enactment. In particular, action phrases are better memory units than cue–target pairs in generation studies. With action phrases, rarely only the verb or the object is remembered. In the generation paradigm, cue and target items are less tightly associated. Based on this feature of cue–target pairs, free recall is usually restricted to target recall, and interitem associations are defined as intertarget associations (e.g., Hirshman & Bjork, 1988; McDaniel et al., 1988).

EXPERIMENT 3

So far, the results of the multiple testing paradigm support clearly the assumption that SPTs provide better item-specific and poorer relational information than do VTs as indicated by more item gains and more item losses in SPTs than in VTs. However, it might be desirable to validate these findings by manipulating item-specific and relational encoding of action phrases directly. We assumed that enactment by the very nature of this task draws attention to single-item processing and thereby distracts attention from relational encoding among the items. Therefore, it is difficult to produce levels-of-processing and generation effects (e.g., Nilsson & Cohen, 1988; Zimmer & Engelkamp, 1999). The situation is different for VTs. Encoding processes of VTs are more flexible. Therefore, levels-of-processing (e.g., Zimmer & Engelkamp, 1999) and generation effects (Nilsson & Cohen, 1988) can be readily observed in VTs. If the reason for the specific SPT findings is indeed focusing on item processing and distracting from relational processing, VTs should produce a similar pattern of findings as

SPTs if the focus is directed on item-specific processing and distracted from relational processing by a corresponding orienting task. To realize such a condition, Experiment 3 was conceived.

Method

Participants

The participants were 30 students of the Saarland University. All the students attended a lecture in general psychology. They were randomly assigned to two groups. One group learned the items in VTs with standard instructions, the other under instructions to assess the frequency of occurrence of the action events. This instruction was intended to focus encoding on the single items. Each group consisted of 15 students.

Material

One out of the three learning lists from Experiment 1 was randomly selected to act as the actual learning list. The list consisted of 42 ordinary action phrases. The list was presented in the same order to both groups of subjects.

Procedure

Participants were tested together in one group. In the beginning each participant was presented a booklet with the instruction and response sheets. Participants were first informed that they would be presented with a list of action phrases, which they should memorize for a later memory test. In addition, half of the participants were asked to assess the frequency with which they had carried out each single action in the last 3 months on a scale from 0 to 4. For this purpose they were presented a rating sheet in their booklet, and as soon as an action phrase was presented during encoding they had to mark their answer on the response sheet. The other half of the participants were only informed that they would be presented with a list of action phrases, which they should memorize for a later memory test. The experimenter read aloud the action phrases with an interstimulus interval of 6 s. Afterwards they carried out five successive free recalls each lasting 4 minutes.

Results

The data of the recall tests are presented in Table 1. The 2 × 5 ANOVA with the factors type of encoding and recall test yielded no significant effect of type of encoding, $F(1, 28) = 2.73$, $MSE = 0.0616$, $p = .11$. There was only a numerical recall advantage of VT + frequency rating (.41) over standard VT (.34). Free recall increases significantly over test trials, $F(4, 112) = 5.57$, $MSE = 0.0013$, $p < .01$. There was no interaction between type of encoding and test trial ($F < 1$).

The data for the recall components are given in Table 2. There were more item gains after VT + frequency rating (8.13) than after standard VT (4.67), $F(1, 28) = 10.13$, $MSE = 2.2238$, $p < .01$. The factor recall test ($F < 1$) as well as the interaction between type of encoding and recall test ($F < 1$) were not significant.

The analysis of losses yielded a significant effect of type of encoding, $F(1, 28) = 6.42$, $MSE = 1.5905$, $p < .05$. There were more losses after VT + frequency rating (6.13) than after standard VT (3.80). Also, the factor recall test was significant, $F(3, 84) = 7.91$, $MSE = 1.1619$,

$p < .01$. The number of losses decreased over recall trials. There was no interaction between type of encoding and recall test ($F < 1$).

Discussion

The findings support the theoretical considerations. Even if the item-specific rating instruction for VTs did not increase free recall statistically over the standard VT instruction, it did so numerically. A comparison with the recall performance of Experiment 1 makes it clear that the performances of VT plus item-specific rating were on the same level as free recall of SPTs in Experiment 1, whereas recall of standard VT was clearly lower in Experiment 1 than in Experiment 3, $t(34) = 3.01$, $p < .01$. This finding suggests that the participants of the VT group in Experiment 3 were particularly good and possibly spontaneously used more active elaboration. More important is the finding that the explicit instruction to focus on item processing in VTs increased the number of item gains and losses compared to a standard VT. These findings show that the orienting task to assess the occurrence frequency of the action events not only increased item processing, but also reduced relational processing. Focusing on item processing distracts, in this case, from encoding interitem relations. The fact that the number of item gains and losses in VTs with the item-specific orienting task corresponded quite closely to those numbers in SPT in Experiment 1 (8.13 vs. 7.67 for item gains and 6.13 vs. 5.48 for item losses) reinforces the assumption that SPTs indeed focus attention on single-item processing and distract it from relational processing.

Although free recall performance increased over trials, and hence there was hypermnesia, this effect hold true for VTs and VTs + frequency ratings in this experiment. However, as separate analyses for VTs and VTs + frequency ratings showed, this increase was significant when frequency rating took place, $F(4, 56) = 4.45$, $MSE = 0.0015$, $p < .01$; but not for standard VTs, $F(4, 56) = 1.37$, $MSE = 0.0011$, $p = .25$. Hence, hypermnesia effects of Experiment 3 were also similar to those of Experiment 1. It suggests that the hypermnesia effect in SPTs is due to a rich item-specific encoding combined with poor relational encoding.

GENERAL DISCUSSION

The three experiments reported here show a consistent pattern of findings. First, the well-established SPT effect was replicated. Second, SPTs produced more item gains and losses than did standard VTs, independent of design type. Third, if in VTs item processing was pushed by an orienting task, more item gains and losses were also observed than under standard VTs. Fourth, there was hypermnesia for VTs and SPTs, although hypermnesia seemed to be more reliable in SPTs.

As was detailed in the Introduction, there is no doubt that there is a robust SPT effect in free recall (see, e.g., Engelkamp, 1998, for a review). There is wide agreement that this effect is due to better item-specific encoding of SPTs than of VTs. However, as has become clear, the evidence is only indirect. Moreover, there is less agreement on the role of relational information in SPTs. For related lists the assumptions and findings are inconsistent, and for unrelated lists this topic has hardly been discussed. The only theoretical discussion was led in the context of PAL. There it was assumed that SPTs provide poorer relational information than do VTs. However, the findings do not allow for firm conclusions.

The experiments presented here served to clarify whether free recall of unrelated action items is based on better item-specific and poorer relational encoding of SPTs than VTs. It was assumed that enactment supports the encoding of single-item contents and at the same time reduces content-based relational encoding compared to VTs. As a means to test these assumptions, the multiple recall testing paradigm was used, and the number of item gains and item losses was taken as index of item-specific and relational information, respectively.

Our findings are fully consistent with the assumptions that SPTs increase item-specific and decrease relational information compared with VTs. Experiment 1 replicated the result of Olofsson (1997) that there are more item gains and losses in SPTs than in VTs for unrelated lists when VTs and SPTs are presented between subjects.

Experiment 2 showed that these findings can be generalized for a within-subjects design of VTs and SPTs. The findings of Experiment 2 allowed at the same time the assumption to be refuted that the poorer relational information of SPTs than of VTs is due to order-based relational information. If this was the case, there should have been no difference in the number of item losses in VTs and SPTs because it is known that order-based encoding is decreased and does not differ if a within-subjects design is used (e.g., Engelkamp & Dehn, 2000; Serra & Nairne, 1993).

Experiment 3 was intended to validate the assumption that focusing attention on single-item processing as in SPTs distracts simultaneously from relating the list items. For this purpose, an orienting task was realized that focused attention of VTs on single-item processing and distracted it from relational encoding. This condition was compared with a standard VT condition. The data showed that the pattern of item gains and losses corresponded closely to that of SPTs—that is, there were more item gains and more losses with the orienting task than with standard VTs. This finding validates the interpretation suggested here for SPTs.

Altogether, the present study has presented direct evidence for the assumption that SPTs provide better item-specific information than do (standard) VTs, and it has presented evidence for the assumption that unrelated list items are more difficult to encode relationally on the basis of the item contents.

The latter finding cannot be directly generalized to related list items. In contrast to unrelated lists, the items of related lists are based on interindividually shared semantic memory structures. It is well documented that these structures evoke automatic semantic priming effects (e.g., Neely, 1977; Perea & Rosa, 2002). It is plausible to assume that the priming effects as far as they are based on automatic spreading activation do not differ between VTs and SPTs. However, differences might arise if the automatic processes are completed or followed by controlled processes. These two factors might explain why the clustering findings for VTs and SPTs with related lists are inconsistent (e.g., Bäckman et al., 1986; Engelkamp & Zimmer, 1996). Moreover, the measure of adjusted ratio of clustering (ARC) that is used in these studies seems to be less sensitive to differences in relational encoding than are item losses (cf., Burns, 1993).

In the present experiments, we observed hypermnesia for VTs as well as for SPTs. Although type of encoding did not significantly interact with recall test, the hypermnesia effect was apparently smaller in VTs than in SPTs. These findings are in line with literature (e.g., Payne, 1987; for an overview; cf., also Mulligan, 2001) according to which under verbal learning standard conditions hypermnesia was not usually observed (see VT standard in

Experiments 1 and 3 of the present study), whereas there was consistently hypermnesia with nonverbal encoding (see SPT in Experiments 1 and 2 of this study). Finally, hypermnesia for verbal tasks is likely if elaboration is induced in verbal tasks (see VT + rating in Experiment 3 of this study). The explanations offered for this pattern of findings are controversial. In the present study, we offered an explanation that refers to the item-specific and relational framework (e.g., Hunt & Einstein, 1981; Hunt & McDaniel, 1993). A prominent alternative is the levels-of-recall view (e.g., Roediger & Challis, 1989; Roediger, Payne, Gillespie, & Lean, 1982). This view assumes that hypermnesia is a function of the recall level (e.g., Roediger et al., 1982). Although the study of hypermnesia was not in the focus of the present study, we will briefly summarize the arguments why this approach does not do well in explaining hypermnesia effects and why the item-relational approach is more successful. There are theoretical and empirical arguments that speak against the recall level approach.

Theoretical arguments against the levels of recall approach are first that it focuses on item gains in order to predict hypermnesia and neglects item losses. For instance, Roediger and Thorpe (1978) do not make predictions about losses. However, ignoring losses cannot explain hypermnesia if item losses rather than item gains are responsible for differential hypermnesia between conditions (e.g., Klein et al., 1989). A second argument against the recall level approach is that there are plausible arguments to assume that the number of item gains increases as well as to assume that it decreases with increase in recall level. Roediger and Thorpe (1978) claim, for instance, that it takes more time to reach an asymptotic recall level the higher the final recall is. Therefore, conditions with higher recall asymptotes should show more gains across repeated tests. Roediger et al. (1982) argue in addition that factors that raise the level of cumulative recall will provide greater opportunity for item gains across trials. Olofsson (1997), on the other hand, argues that a lower initial free recall provides the greater potential for recoveries with repeated testing than a higher initial free recall because more initially unrecalled items are available for recovery in the former than in the latter case.

Hence, a recall level view leads obviously to contradictory predictions, and it does not take losses into account. However, losses must be considered to explain hypermnesia.

Besides the theoretical deficits, empirical findings speak against the recall level hypothesis to explain hypermnesia. It has been shown that the number of gains may differ even if the initial recall and the overall recall do not (Burns & Schoff, 1999; Payne, 1986). In order to demonstrate that also for SPTs the number of item gains and losses can differ if the initial recall level is kept constant, we compared the number of item gains and losses from Experiment 1 of the present study (initial free recall = .37, average free recall = .39) with those from Experiment 3 of another study from our laboratory which happened to produce the same initial (.37) and average free recall level (.40, Experiment 3 of Engelkamp & Seiler, 2002). The only difference of both experiments was that in the present experiment unrelated lists were used and in the other one related lists. Despite the fact that recall levels were matched, the number of item gains (7.67 vs. 10.58), $t(45) = 2.07$, $p < .05$, as well as the number of item losses (5.48 vs. 8.19), $t(45) = 1.97$, $p = .05$, were higher with related than with unrelated lists. Furthermore, an increased recall level may be accompanied by an increased or decreased number of losses (e.g., Burns, 1993; Klein et al., 1989; Payne, 1986).

In addition, we computed correlations between free recall and the number of gains as well as between free recall and the number of losses for the different recall trials of the present experiments. These coefficients were almost consistently nonsignificant for item losses. The results were inconsistent for item gains. Moreover, there was no correlation between the number of item gains and losses. Both can vary independently of each other. Taken together, also the correlational findings do not support the assumption that the number of gains or losses depend consistently on the initial or average recall level.

The findings that item gains and losses can vary independently of each other makes clear that a theory that takes the number of item gains and losses into account is needed in order to predict hypermnesia. Such a theory is suggested by the item-relational distinction account. It makes separate predictions with regard to the number of gains and losses. It predicts hypermnesia if the number of gains across test trials surpasses the number of losses. This case may occur if the number of gains remains constant, and the number of item losses decrease across trials, if the number of item losses is constant, and the number of item gains increases across trials, or if the number of item losses decreases, and the number of item gains increases.

However, in the present paper we did not focus on the number of item gains and item losses within one condition, but on the difference of the number of gains and losses between the two encoding conditions VT and SPT. We treated the number of gains and losses as indicating the amount of item-specific and relational information provided by unrelated lists of VTs and SPTs. Our predictions were that SPTs provide more item-specific and less relational information. These predictions were confirmed by showing more item gains and losses in SPTs than in VTs.

This pattern of findings was shown before by a single experimental study of Olofsson (1997). We considered a replication of this basic pattern under slightly modified conditions to be necessary before more specific aspects of the item-relational framework could be considered in Experiments 2 and 3.

Experiment 2 used a within-subjects design for type of encoding, because it is known that in such a design order-relational differences disappear (e.g., DeLosh & McDaniel, 1996; Engelkamp & Dehn, 2000; Serra & Nairne, 1993). From the item-relational framework as presented here it follows that order-relational information differs from content-based relational information and that content-based relational information should differ also in a within-subjects design. This assumption was confirmed. The number of losses was also greater after SPTs than after VTs in a within-subjects design.

Experiment 3 focused on item-specific information and predicted an increased number of gains if the task demanded to process more item-specific information in VTs. This prediction was also confirmed.

REFERENCES

Bäckman, L., Nilsson, L. G., & Chalom, D. (1986). New evidence on the nature of the encoding of action events. *Memory & Cognition*, *14*, 339–346.

Basden, B. H., Basden, D. R., & Gargano, G. J. (1993). Directed forgetting in implicit and explicit memory tests: A comparison of methods. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *19*, 603–616.

Burns, D. J. (1993). Item gains and item losses during hypermnesic recall: Implications for the item-specific-relational information distinction. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *19*, 163–173.

Burns, D. J., Curti, E. T., & Lavin, J. C. (1993). The effects of generation on item and order retention in immediate and delayed recall. *Memory & Cognition*, *21*, 846–852.

Burns, D. J., & Schoff, K. M. (1999). Slow and steady often ties the race. The effects of item-specific and relational processing on cumulative recall. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *24*, 1041–1051.

Burns, D. J., & Gold, D. E. (1999). An analysis of item gains and losses in retroactive interference. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *25*, 978–985.

Craik, F. I. M., & Tulving, E. (1975). Depth of processing and the retention of words in episodic memory. *Journal of Experimental Psychology: General*, *104*, 268–294.

DeLosh, E. L., & McDaniel, M. A. (1996). The role of order information in free recall: Application to the word-frequency effect. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *22*, 1136–1146.

Ecker, W., & Engelkamp, O. (1995). Memory for actions in obsessive-compulsive disorder. *Behavioral and Cognitive Psychotherapy*, *23*, 349–371.

Einstein, G. O., & Hunt, R. R. (1980). Levels of processing and organization: Additive effects of individual item and relational processing. *Journal of Experimental Psychology: Human Learning and Memory*, *6*, 588–598.

Engelkamp, J. (1986). Nouns and verbs in paired-associate learning: Instructional effects. *Psychological Research*, *48*, 153–159.

Engelkamp, J. (1988). Modality-specific encoding and word class in verbal learning. In M. Gruneberg, P. Morris, & R. N. Snykes (Eds.), *Practical aspects of memory* (Vol. 1, pp. 415–420). Chichester: J. Wiley.

Engelkamp, J. (1995). Visual imagery and enactment of actions in memory. *British Journal of Psychology*, *86*, 227–240.

Engelkamp, J. (1997). Memory for to-be-performed tasks versus memory for performed tasks. *Memory & Cognition*, *25*, 117–124.

Engelkamp, J. (1998). *Memory for actions*. Hove, UK: Psychology Press.

Engelkamp, J., & Dehn, D. M. (2000). Item and order information in subject-performed tasks and in experimenter-performed tasks. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *26*, 671–682.

Engelkamp, J., & Seiler, K. (2002). *Automatic and controlled encoding of categorical information in memory for action events*. Manuscript submitted for publication.

Engelkamp, J., Mohr, G., & Zimmer, H. D. (1991). Pair-relational encoding of performed nouns and verbs. *Psychological Research*, *53*, 232–239.

Engelkamp, J., & Zimmer, H. D. (1996). Organisation and recall in verbal tasks and in subject-performed tasks. *European Journal of Cognitive Psychology*, *8*, 257–273.

Engelkamp, J., & Zimmer, H. D. (1997). Sensory factors in memory for subject-performed tasks. *Acta Psychologica*, *96*, 43–60.

Erdelyi, M. H., & Becker, J. (1974). Hypermnesia for pictures: Incremental recall for pictures but not for words in multiple test trials. *Cognitive Psychology*, *6*, 159-171.

Fischler, I., & Goodman, G. O. (1978). Latency of associative activation in memory. *Journal of Experimental Psychology: Human Perception and Performance*, *4*, 455–470.

Helstrup, T. (1986). Separate memory laws for recall of performed acts? *Scandinavian Journal of Psychology*, *27*, 1–29.

Hirshman, E., & Bjork, R. A. (1988). The generation effect: Support for a two-factor theory. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *14*, 484–494.

Hunt, R. R., & Einstein, G. O. (1981). Relational and item-specific information in memory. *Journal of Verbal Learning and Verbal Behavior*, *20*, 497–514.

Hunt, R. R., & McDaniel, M. A. (1993). The enigma of organization and distinctiveness. *Journal of Memory and Language*, *32*, 421–445.

Klein, S. B., Loftus, J., Kihlstrom, J. F., & Aseron, R. (1989). Effects of item-specific and relational information on hypermnesic recall. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *15*, 1192–1197.

Knopf, M. (1991). Having shaved a kiwi fruit: Memory of unfamiliar subject-performed actions. *Psychological Research*, *53*, 203–565.

Marschark, M., Richman, C. L., Yuille, J. C., & Hunt, R. R. (1987). The role of imagery in memory: On shared and distinctive information. *Psychological Bulletin*, *102*, 28–41.

McDaniel, M. A., Einstein, G. O., DeLosh, E. L., May, C., & Brady, P. (1995). The bizarreness effect: It's not surprising, it's complex. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *21*, 422–435.

McDaniel, M. A., Einstein, G. O., Dunay, P. K., & Cobb, R. E. (1986). Encoding difficulty and memory: Toward a unifying theory. *Journal of Memory and Language*, *25*, 645–656.

McDaniel, M. A., Moore, B. A., & Whiteman, H. L. (1998). Dynamic changes in hypermnesia across early and late tests: A relational/item-specific account. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *24*, 173–185.

McDaniel, M. A., Waddill, P. J., & Einstein, G. O. (1988). A contextual account of the generation effect: A three-factor theory. *Journal of Memory and Language*, *27*, 521–536.

Meyer, D. E., & Schvaneveldt, R. W. (1971). Facilitation in recognizing pairs of words: Evidence of a dependence between retrieval operations. *Journal of Experimental Psychology*, *90*, 227–234.

Mohr, G., Engelkamp, J., & Zimmer, H. D. (1989). Recall and recognition of self-performed acts. *Psychological Research*, *51*, 181–187.

Mulligan, N. W. (1999). The effects of perceptual interference at encoding on organization and order: Investigating the roles of item-specific and relational information. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *25*, 54–69.

Mulligan, N. (2001). Generation and hypermnesia. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *27*, 436–450.

Nairne, J. S., Pusen, C., & Widener, R. J., Jr. (1985). Representation in the mental lexicon: Implications for theories of the generation effect. *Memory & Cognition*, *13*, 183–191.

Neely, J. H. (1977). Semantic priming and retrieval from lexical memory: Roles of inhibitionless spreading activation and limited capacity attention. *Journal of Experimental Psychology: General*, *106*, 226–254.

Nilsson, L. G. (2000). Remembering actions and words. In F. I. M. Craik & E. Tulving (Eds.), *Oxford handbook of memory* (pp. 137–148). Oxford: Oxford University Press.

Nilsson, L. G., & Cohen, R. (1988). Enrichment and generation in the recall of enacted and non-enacted instructions. In M. M. Gruneberg, P. E. Morris, & R. N. Sykes (Eds.), *Practical aspects of memory: Current research and issues* (Vol. 1, pp. 427–432). Chichester: John Wiley & Sons.

Nilsson, L. G., Cohen, R., & Nyberg, L. (1989). Recall of enacted and nonenacted instructions compared: Forgetting functions. *Psychological Research*, *51*, 188–193.

Nilsson, L. G., & Craik, F. I. M. (1990). Additive and interactive effects in memory for subject-performed tasks. *European Journal of Cognitive Psychology*, *2*, 305–324.

Nyberg, L., & Nilsson, L. G. (1995). The role of enactment in implicit and explicit memory. *Psychological Research*, *57*, 215–219.

Olofsson, U. (1997). Win some, lose some: Hypermnesia for actions reflects increased item-specific processing. *Memory & Cognition*, *25*, 797–800.

Payne, D. G. (1986). Hypermnesia for pictures and words: Testing the recall level hypothesis. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *12*, 16–29.

Payne, D. G. (1987). Hypermnesia and reminiscence in recall: A historical and empirical review. *Psychological Bulletin*, *101*, 5–27.

Perea, M., & Rosa, E. (2002). The effects of associative and semantic priming in the lexical decision task. *Psychological Research*, *66*, 180–194.

Roediger, H. L., & Challis, B. H. (1989). Hypermnesia: Improvements in recall with repeated testing. In C. Izawa (Ed.), *Current issues in cognitive processes: The Tulane Flowern Symposium on Cognition* (pp. 175–199). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Roediger, H. L., Payne, D. G., Gillespie, G. L., & Lean, D. S. (1982). Hypermnesia as determined by level of recall. *Journal of Verbal Learning and Verbal Behavior*, *21,* 635–655.

Roediger, H. L., & Thorpe, L. A. (1978). The role of recall time in producing hypermnesia. *Memory & Cognition*, *6*, 296–305.

Serra, M., & Nairne, J. S. (1993). Design controversies and the generation effect: Support for an item-order hypothesis. *Memory & Cognition*, *21*, 34–40.

Steffens, M. C., & Erdfelder, E. (1998). Determinants of positive and negative generation effects in free recall. *Quarterly Journal of Experimental Psychology*, *51A*, 705–733.

Zimmer, H. D. (2001). Why do actions speak louder than words. Action memory as a variant of encoding manipulations or the result of a specific memory system? In H. D. Zimmer, R. Cohen, M. J. Guynn, J. Engelkamp, R. Kormi-Nouri, & M. A. Foley (Eds.), *Memory for action: A distinct form of episodic memory?* (pp. 151–198). New York: Oxford University Press.

Zimmer, H. D., & Engelkamp, J. (1989). Does motor encoding enhance relational information? *Psychological Research*, *51*, 158–167.

Zimmer, H. D., & Engelkamp, J. (1999). Levels of processing effects in subject-performed tasks. *Memory & Cognition*, *27*, 907–914.

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