Psychonomic Bulletin & Review
2004, 11 (2), 367–372

Memory for actions: Enactment and source memory

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Enacting simple action phrases enhances item memory but may not enhance other aspects of memory. The present experiment examines the effects of enactment on source memory. During the study phase, participants performed some actions (subject-performed tasks, SPTs) and observed the experimenter perform other actions (experimenter-performed tasks, EPTs). One group performed the SPTs with eyes closed, one group with eyes open (the standard condition), and one group performed SPTs facing a mirror (EPT presentation was constant across groups). As expected, item memory was better for SPTs than for EPTs. More importantly, source memory for SPTs was affected by the amount of visual feedback. As predicted by the source-monitoring framework, source memory for SPTs decreased as the amount of visual feedback increased from none (eyes closed) to moderate (standard condition) to maximal (mirror condition). In addition, SPT encoding failed to increase source memory and in one condition actually decreased source memory, relative to EPT encoding. Thus, enactment dissociated item and source memory, enhancing the former but not the latter.

Over the last 20 years, there has been an increasing interest in the role of action in later memory. One of the fundamental findings is that action phrases (such as *break the toothpick*) are remembered better when they are acted out (R. L. Cohen, 1981). Such subject-performed tasks (SPTs) produce better recall and recognition than is found when the same action phrases are read (verbal tasks, or VTs) or imagined, or when the participant watches an experimenter carry out the tasks (experimenter-performed tasks, or EPTs) (Engelkamp, 1998; Nilsson, 2000).

Although enactment leads to superior memory for the occurrence of the action phrase, enactment may not enhance (and may even disrupt) other types of memorial information. For example, Olofsson (1996) and Engelkamp and Dehn (2000) have reported that memory for temporal order can be impaired by enactment. Engelkamp and Zimmer (1996) reported no difference between VTs and SPTs in the amount of category clustering at recall, an indication of equivalent amounts of relational encoding. Finally, in Koriat, Ben-Zur, and Druch's (1991) study, enactment disrupted memory for spatio-temporal context. Such findings are consistent with a dominant theoretical account of the SPT effect which proposes that enactment enhances item-specific information but does not enhance (and may even disrupt) associative information underlying memory for order, context, and source (Engelkamp, 1998, 2001).

In the present experiment, we examined the effect of enactment on memory for source: the knowledge of whether an action has been observed (i.e., the EPT condition) or performed by oneself (i.e., the SPT condition).[1] We are interested in the general issue of how enactment affects source memory and in more detailed questions that arise from a consideration of enactment in terms of the source-monitoring framework of Johnson and colleagues (Johnson, Hashtroudi, & Lindsay, 1993; Mitchell & Johnson, 2000). According to the source-monitoring model, source judgments are based on two processes: (1) a rapid (heuristic) decision based on the qualitative characteristics of the memory trace, and (2) a slower, more strategic process based on metamemorial knowledge. Johnson et al. (1993; Mitchell & Johnson, 2000) have suggested that most source judgments are made heuristically, especially when prior knowledge about the sources is missing or sparse, as is typically the case in experimental studies. Consequently, here we focus only on the heuristic process.

The source-monitoring framework conceives of memory traces as sets of features from which source is inferred. Memory traces contain not only information specifying the event itself (e.g., the study word, action phrase), but also information about perceptual features (e.g., color, sound), contextual information (e.g., spatial information), affective information (e.g., emotional reactions), and the cognitive operations (e.g., reflective processes, elabora-

This paper is based in part on S.L.H.'s dissertation under the direction of N.W.M. We gratefully acknowledge the assistance of the other members of the dissertation committee, Alan Brown, Jim Bartlett, and Curt McIntyre. Address correspondence to N. W. Mulligan, Department of Psychology, University of North Carolina, Chapel Hill, NC 27599-3270 (e-mail: nmulligan@unc.edu).

tions) engaged when the memory is created (Johnson et al., 1993). Internally initiated and externally perceived memories typically differ in several ways. Most important for our present purposes, external memories tend to include more perceptual information, whereas internally generated memories are characterized by more information about cognitive operations (Johnson et al., 1993; Mitchell & Johnson, 2000). According to the source-monitoring framework, memories with large amounts of information about cognitive operations would most likely be identified as internally generated, whereas memories with large amounts of perceptual information, but little information about cognitive operations, should be attributed to an external source.

When the characteristics of a memory are not typical of its class, source monitoring suffers. For instance, perceived items that include substantial information about cognitive operations are likely to be mistakenly judged as internally generated (Johnson et al., 1993). In addition, the more an internally initiated event resembles a perceived event, the more likely it will mistakenly be labeled as external (Mitchell & Johnson, 2000). Finally, dissociations between item and source memory support the distinction between these aspects of memory, demonstrating both the inferential nature of source memory and the fact that source memory is not simply a function of encoding strength (e.g., Johnson et al., 1993; Jurica & Shimamura, 1999; Mulligan & Hirshman, 1997).

Applying the source-monitoring framework to action memory raises some interesting implications. Because EPTs are entirely external events, perceptual (especially, visual) information should predominate. SPTs, on the other hand, are internally initiated, implying that more information about cognitive operations should be encoded for SPTs than for EPTs. Consistent with these notions, research on action memory indicates that perceptual information, especially visual information, is not critical to the SPT effect but is an important aspect of the encoding of EPTs (e.g., Engelkamp, Zimmer, & Biegelmann, 1993; Mulligan & Hornstein, 2003; see Engelkamp, 2001, for a review). If so, it should be possible to manipulate the encoding of action events to vary the amount of perceptual information associated with SPTs. In particular, increasing visual information during the encoding of SPTs should increase source-monitoring confusions because of a greater overlap with perceived (EPT) items. Decreasing visual information, on the other hand, should render SPT traces more distinct from EPT traces, thereby improving source judgments.

In the present experiment, SPTs were encoded under varying levels of visual feedback. In the first condition, participants performed some actions and watched the experimenter perform others (a standard SPT manipulation). The second condition restricted visual information for the SPT items by requiring participants to perform these actions with their eyes closed. The third group received enhanced visual feedback, performing SPTs in front of a mirror, which should increase attention to and encoding of visual information for SPTs. (In all conditions, the EPT items were presented in the standard way.)

Enactment was expected to enhance item memory in all groups, because visual information is not critical to the SPT effect in item memory (Engelkamp, 2001). In contrast, visual feedback was expected to affect source memory. The source-monitoring framework suggests that as visual feedback increases, SPTs become increasingly similar to EPTs, which should produce an increasing tendency for SPT items to be mistaken for EPT items. As such, source memory for SPTs should be worst in the mirror condition, better in the standard condition, and best in the eyes-closed condition.

The primary focus of the present study is the effect of visual feedback during enactment on source memory. In addition, we assess the more basic question of how enactment affects source memory. There are a few studies on this issue, but none provides an ideal assessment of the question. Next, we review these studies (and their limitations) in order to develop the methodology for the present study.

Koriat et al. (1991) examined item versus contextual memory by presenting participants with action events in two settings. Participants were tested in pairs, each alternating between enacting and observing. Halfway through the study, one participant in each pair was moved to a different room with a new partner and continued to enact and observe events. At test, the participants were presented with all items, and they were instructed to indicate in which phase the task had taken place. Item memory was better for the enacted items, but context memory was superior for the observed actions. If memory for study phase is conceived of as a type of source, this result implies that source memory is disrupted by enactment. However, there was an important limitation in this study. The observed actions were carried out by different partners across the contexts (i.e., the other person in the enacting dyad varied across phases), whereas self-enacted items were, of course, carried out by the same person across contexts. This may have inflated accuracy in the *observe* condition. Specifically, if one recalls which partner performed an action, the study phase can be accurately inferred. In contrast, recalling that an action was self-enacted does not specify the study phase. Thus, in the Koriat et al. experiment, there was more context-specifying information for observed than for enacted items.

In G. Cohen and Faulkner's (1989) experiment, study actions described the movement of objects around a grid (e.g., "put the spoon next to the toothbrush," "put the stamp on the book"). The participants performed some of the actions and watched the experimenter perform others (they imagined still other actions). The test was a source recognition test in which the new items were recombinations of old objects and actions (e.g., "put the toothbrush on the book"). Performing produced superior item memory, but performing and watching produced approximately equivalent source memory (Conway & Dewhurst, 1995, using the same materials, report the same results). For our present purposes, the limitations of this study were twofold. First, there was no direct statistical comparison of the *perform* and *watch* conditions (nor was there in Conway & Dewhurst, 1995). Second, the fact that new items were recombinations of old objects and actions may have limited the generality of the results. In typical tests for action memory, either there are no distractors (i.e., memory is assessed with free or cued recall) or the distractors are completely new objects or actions. It seems likely that the testing technique of G. Cohen and Faulkner places much greater weight than do standard testing techniques on the extent to which objects and actions had been integrated at encoding (Nilsson, 2000).

In a recent ERP study (Senkfor, Van Petten, & Kutas, 2002), participants generated and performed typical actions for some objects, and they watched the experimenter perform typical actions for other objects. In contrast to the findings in the previous studies, source memory was better in the perform than in the watch condition. However, this study also had limitations. First, the memory test contained no new items and thus provided no measure of item memory. Consequently, it is unclear whether the typical SPT effect would have been obtained in item memory, and this makes it harder to interpret the source memory results. Second, the perform condition had a generation component that was not present in the watch condition; in the perform condition, the participants had to generate the action before performing it, whereas in the watch condition, the action was neither generated nor enacted by the participant. This is problematic for two reasons. First, unlike the watch items, the perform items were not fully under experimental control, raising the possibility of item selection effects. Second, superior source memory in the perform condition relative to the watch condition could have been due to generation rather than enactment per se; generation enhances source memory under some conditions (Marsh, Edelman, & Bower, 2001).[2]

In the present study, we sought to circumvent these issues. The recognition test contained new items, allowing us to verify the presence of the typical SPT effect in item memory (cf. Senkfor et al., 2002). The memory test was a standard test, in that the new items did not use objects from the study episode (cf. G. Cohen & Faulkner, 1989). Finally, only one actor was used in the EPT condition (cf. Koriat et al., 1991). In addition, the experiment was designed to assess the effects of visual feedback so that we could relate the enactment effect to the source-monitoring framework.

METHOD

Participants

Ninety undergraduates participated in exchange for credit in psychology courses.

Design and Materials

The experiment had a 2 × 3 design, with encoding condition (SPT vs. EPT) manipulated within subjects and visual feedback (mirror, standard, or eyes closed) manipulated between subjects. The participants were divided evenly across the visual feedback conditions.

Ninety simple action phrases (e.g., *break the toothpick*) served as the critical items (many from R. L. Cohen, 1981). These items were randomly divided into three sets, and each set was rotated through the SPT, EPT, and a nonstudied condition. This produced three study lists, with each critical item appearing equally often in each condition. Four additional items were placed at the beginning of the study lists as practice items.

Procedure

The experiment began with the study phase, during which the participant and the experimenter sat facing each other (at a distance of approximately 4 ft) so that each had a clear view of the other. The standard condition followed the common procedures of the enactment paradigm (Engelkamp & Zimmer, 1997). In this condition, the participants were informed that they would hear a series of action events, some of which they would perform and some of which the experimenter would perform. The participants were instructed to pay attention to all of the tasks for a later (unspecified) memory test. Each action was read aloud by the experimenter. SPT and EPT items were alternately presented in sets of five. Each set was preceded by the instructions "experimenter" or "participant," indicating who was to perform the set of actions. For all items, the experimenter produced the object while reading the action, and the appropriate person enacted the event. Immediately after the action was completed, the object was removed from view (all objects were hidden from participants' view at all times, except when in use).

The eyes-closed condition was identical to the standard condition with the exception that participants were instructed to close their eyes while enacting SPT items and to open their eyes for EPT items. Specifically, in the SPT condition, the participant closed his/her eyes and listened to actions read by the experimenter. The object was then placed into the hands of the participant, who performed the task. The object was then taken out of the hands of the participant and was removed from view before the participant opened his/her eyes. The experimenter monitored each action, ensuring that the participants followed the instructions correctly.

In the mirror condition, a mirror (measuring 16 in. × 48 in.) was situated 2.5 ft to the left of the experimenter. The participants in this condition were instructed to watch themselves in the mirror as they performed the SPT actions. The participant sat in a swivel chair (as in all conditions), making it easy to adjust the view, facing the experimenter for the EPT items and the mirror for the SPT items. The experimenter monitored the participants to ensure that the instructions were followed. Otherwise, the mirror condition was identical to the standard condition.

The memory test was given 48 h later. The participants were presented with a printed list of all 90 critical items in a random order. The participants were asked to indicate whether the item had been enacted by the experimenter or by themselves, or whether the action was new, by circling "experimenter," "self," or "new" next to each item. The test phase was self-paced.

RESULTS

To measure item memory, responses of "experimenter" or "self" were scored as *old* and accuracy was assessed with corrected-hit rates (d' analyses produced consistent results). Source memory was assessed with the identification-of-origin score (Johnson et al., 1993), defined as the proportion of items correctly recognized as *old* that were attributed to their correct source. The results are summarized in Tables 1 and 2.

Table 1
Mean Item Memory Performance (With Standard Deviations) as a Function of Encoding and Visual Feedback

	Visual Feedback					
	Eyes Closed		Standard		Mirror	
Encoding Condition	*M*	*SD*	*M*	*SD*	*M*	*SD*
Hits						
Subject-performed task	.88	.09	.86	.10	.82	.11
Experimenter-performed task	.82	.11	.81	.14	.74	.17
False Alarms	.14	.08	.13	.10	.11	.09
Corrected Hits						
Subject-performed task	.74	.09	.73	14	.71	.13
Experimenter-performed task	.68	.13	.68	.17	.63	.20

Table 2
Mean Source Memory Performance (With Standard Deviations) as a Function of Encoding and Visual Feedback

	Visual Feedback					
	Eyes Closed		Standard		Mirror	
Encoding Condition	*M*	*SD*	*M*	*SD*	*M*	*SD*
Subject-performed task	.91	.06	.87	.11	.82	.09
Experimenter-performed task	.89	.10	.88	.08	.90	.11

Item Memory

Corrected hits were analyzed with a 2 (encoding condition) × 3 (visual feedback) analysis of variance (ANOVA) (all statistical tests used an α level of .05). The analysis revealed a main effect of encoding [$F(1,87) = 26.93, MS_e = .0065$], indicating better item memory for SPTs than for EPTs. There was no effect of visual feedback, nor was there an interaction (Fs < 1). The false alarm rate did not differ across groups ($F < 1$).

Source Memory

Identification-of-origin scores were submitted to a 2 (encoding condition) × 3 (visual feedback) ANOVA. The encoding × visual feedback interaction was significant [$F(2,87) = 4.84$, $MS_e = .0075$]. The main effects of encoding and visual feedback were not significant ($F = 2.67, p = .11$, and $F = 2.15, p = .12$, respectively).

To examine the significant interaction, SPTs and EPTs were analyzed separately. For EPTs, there was no effect of visual feedback ($F < 1$). For SPTs, there was a significant effect [$F(2,87) = 6.61$, $MS_e = .0083$], concentrated in a highly significant linear trend [$F(1,87) = 13.12$, $MS_e = .0083$], indicating that increasing visual feedback produced consistently worse source memory, from eyes closed to the standard condition to the mirror condition. As predicted, SPTs were increasingly mistaken for EPTs across the visual feedback conditions. In contrast, the relative proportion of EPTs mistaken for SPTs did not vary. In addition, the effect of encoding condition was evaluated within each of the visual feedback groups. In the mirror condition, SPTs produced significantly worse source memory than did EPTs [$t(29) = 3.32$], whereas in the standard and eyes-closed conditions, there was no significant effect ($|t|$s < 1).[3]

Finally, *new* items incorrectly judged as *old* were more likely to be attributed to the experimenter ($M = .081$) than to oneself ($M = .045$) [$t(89) = 4.33$]. This is a demonstration of the "it had to be you" effect (Johnson et al., 1993), in which false alarms are more likely to be attributed to an external source, in this case the experimenter.

DISCUSSION

SPTs produced better item memory than did EPT items, which replicates the typical effect of enactment (Engelkamp, 1998) and facilitates interpretation of the source memory results (cf. Senkfor et al., 2002). The SPT effect was obtained across varying levels of visual feedback, a result that was expected and is consistent with the motor-encoding view of the SPT effect (Engelkamp, 1998, 2001). According to this view, motor output information is the critical type of item-specific information in the SPT memory trace. Consequently, variation in the amount of visual feedback should neither eliminate nor enhance the typical SPT effect, provided that motor output is not inadvertently affected. Related is the finding of an SPT effect in the eyes-closed condition. This indicates that the SPT advantage in item memory persists in the absence of visual feedback. This finding extends the results of Engelkamp et al. (1993), who reported similar results for SPTs versus VTs.

With respect to source memory, the implications of the source-monitoring framework were borne out. With increasing amounts of visual feedback, SPT items were more likely to be mistaken for EPTs. This is consistent with the assumption that EPT items, as purely external events, have more vivid visual features. In contrast, SPT items are internally initiated and feature less extensive encoding of visual information (Engelkamp, 2001). When the amount of visual information is decreased, as in the eyes-closed condition, the SPT traces contain even less visual information than is typical, making them easier to distinguish from EPT traces. Alternatively, increasing the amount of visual information in the SPT condition, by directing participants to watch themselves in a mirror, produces memory traces more easily mistaken for purely externally experienced events.

A more general issue is the effect of enactment on source memory. In contrast to its positive effect on item memory, enactment produced either no enhancement (in the eyes-closed and standard conditions) or worse source memory (in the mirror condition). Consider first the standard condition, which bears the closest similarity to prior research. In this condition, enactment, relative to EPTs, enhanced item memory but produced no effect on source memory. This aspect of our results is consistent with the results of G. Cohen and Faulkner (1989; cf. Conway & Dewhurst, 1995), who used the more common testing method in which the *new* objects on the test were actually new in the context of the experiment. This result diverges from the findings of Koriat et al. (1991), who obtained worse context recall for performed than for watched actions, and from those of Senkfor et al. (2002), who obtained the opposite—improved source memory for SPTs. As described above, neither of these studies is ideal for assessing the effects of enactment on source memory (consider, for example, the confound in the number of actors across the performed and watched conditions in Koriat et al.'s experiments, and the fact of the generate component in the SPT but not the EPT condition in Senkfor et al.'s experiment). Indeed, these differences might account for the divergent results if, in Koriat et al.'s study, multiple partners and rooms produced a focus on external/visual information during enactment and if, in the case of Senkfor et al.'s study, the generation component produced a focus on cognitive operations during enactment. According to the source-monitoring framework, the preferential processing of external information in the former case is expected to produce poorer source memory for SPTs, whereas the enhanced encoding of internal information in the latter case is expected to produce better source memory.

In contrast to the standard and eyes-closed conditions, the mirror condition evinced a complete reversal of the effect of enactment; the SPT condition produced both better item memory and worse source memory than did the EPT condition. As discussed above, it appears that because participants' attention was focused on visual information, the resulting SPT traces were more likely to be mistaken for EPTs, rendering worse source memory.[4] However, as long as the critical motor information is not affected, enactment's positive effect on item memory persists.

Finally, the entire pattern of results represents a dissociation between item and source memory—in fact, two dissociations. First, enactment enhanced item memory but not source memory. Second, the SPT effect in item memory was unmodified by visual feedback, whereas the SPT effect in source memory was influenced by visual feedback (the effect was null in the eyes-closed and standard conditions, and negative in the mirror condition). These dissociations join a number of other dissociations between item and source memory (Johnson et al., 1993), indicating that information underlying item memory may be distinct from source-specifying information in memory.

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NOTES

1. There was no VT condition in the present experiment. The effects of enactment proper are more appropriately assessed with the SPT versus EPT comparison rather than the SPT versus VT comparison. The former comparison more closely matches the conditions on the nonenactment aspects of the item (e.g., presence of the object).

2. A few other studies of source memory with SPT and EPT conditions are likewise uninformative for our present purposes. In Foley and Johnson (1985) and Foley and Ratner (1998), one group of participants performed and watched actions (another group watched two experimenters perform actions, and a third group performed and imagined actions). Because the goal of these studies was to compare a group with one internal (SPT) and one external (EPT) source with groups having either two internal or two external sources, the reported source memory performance was averaged over the SPT and EPT conditions, making a comparison of source memory in the SPT and EPT conditions unavailable. Carroll, Mazzoni, Andrews, and Pocock (1999), in a study of metamemory and source memory, required participants to recall actions and then make source judgments. The source judgments in this case were

conditional on correct recall (which, problematically, varied across encoding conditions, giving rise to potential item selection effects in the source memory measure).

3. Given the relatively high level of source memory performance, there could be a concern that potential differences between the SPT and EPT conditions are masked by ceiling effects. To investigate, we divided each group (by median split) into high and low performers on the basis of average source-monitoring performance. The analysis of the low performers, for whom ceiling effects were not an issue, produced the same pattern of results as that reported above: (1) Visual feedback significantly affected source memory for SPTs but not for EPTs; and (2) in the mirror condition, SPTs produced significantly worse source memory than did EPTs, whereas in the other two conditions there was no significant difference.

4. Note that this visual information presumably does not specify the actor (e.g., facial features, hair color, etc.). Otherwise, source memory would not be expected to suffer. It seems likely that the participant focused visual attention on the objects and actions themselves rather than on the face of the actor.

(Manuscript received July 26, 2002;
revision accepted for publication April 8, 2003.)