The effect of study-phase length on auditory false recognition

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Studying a list of words that are semantically related to an unseen word creates a false recognition. In the visual domain, research shows that false recognition increases when the length of the study phase is extended. This study examined whether the increase in false recognition is specific to the visual domain, or if it is common to another modality, such as the auditory domain. The results demonstrate that auditory false recognition increases when the insertion of an extra blank interval between words or between lists lengthens the study phase. Therefore, these findings suggest that processes not specific to visual modality mediate the effect of study phase length on false recognition.

Key words: false recognition, length of study phase, auditory modality

Our memories do not always reflect our actual experiences. We sometimes remember or recognize events that we never actually experienced. Researchers have used the Deese–Roediger–McDermott (DRM) paradigm (Deese, 1959; Roediger & McDermott, 1995) to measure reports of non-experienced events, known as false memories (specifically, false recall and false recognition). Participants in DRM-paradigm studies are asked to study several lists of words. For every list shown, researchers assign a semantically related, yet non-presented “lure” word. After studying the word lists, participants take a recall and/or recognition test. Typically, participants falsely recall and/or recognize the lure words more frequently than they do non-presented, unrelated control words.

Previous research has revealed several factors that increase false memory in the DRM paradigm (e.g., Roediger & McDermott, 2000). For example, the length of the study phase has been shown to increase false recognition. Arndt and Hirshman (1998) manipulated the length of the study phase by varying the presentation rate of study words (300, 500, 800, or 3000 ms per word). On subsequent visual recognition tests, participants demonstrated greater rates of false recognition as the presentation rate slowed.

Much of the research examining the effect of study-phase length presented words visually in both the study and test phases (Arndt & Hirshman, 1998; Seamon, Luo, & Gallo, 1998; McDermott & Watson, 2001). The question arises as to whether using another modality (e.g., the auditory domain) produces similar effects. Therefore, this study examines the effect of the study-phase length when words are presented auditorily.

Specifically, this study tested whether false recognition increased by extending the length of the study phase. We extended the study phase in two ways. First, an extra blank space was inserted after each word (the word-delay condition, see Figure 1). We then compared the amount of false recognition under this word-delay condition with that of the baseline condition. We hypothesized that if the length of the study phase governing the degree of false recognition is not specific to the visual domain, we would
obtain similar degrees of false recognition when we increased the length of the study phase in the auditory domain.

The second way that we extended the study phase was to insert an extra blank space between the presentations of each list (the list-delay condition, see Figure 1) while keeping the duration of a list the same as that of the baseline conditions. To our knowledge, no previous studies have used such techniques. Previous studies (e.g., Arndt & Hirshman, 1998; Seamon et al., 1998) that presented visual words extended the study period by lengthening the duration of the words as shown by the word-delay condition (see above). Therefore, it is unclear whether the effects of an extended study phase occur due to the insertion of an extra period after each list. We hypothesized that if an increase in false recognition under the word-delay condition was not specific to that condition, a similar increase would occur under the list-delay condition.

**Method**

**Participants:** The participants were 48 experimentally naive students at Hiroshima University who volunteered either for course credits or remuneration. Participants were randomly assigned to one of the three study conditions (word-delay, list-delay, and baseline conditions), with 16 participants in each group.

**Material:** Overall, 20 lists of 15 concrete words were used for a total of 300 words. Each list consisted of words belonging to a common category (e.g., cooking knife, cutting board, etc. under the category of "Kitchen Utensils"). Based on the results of a pilot study (see Nabet & Kawahara, in press) in which 15 experimentally naive adults rated the familiarity of words in each category, we arranged the order of the words from most to least familiar for each list, keeping the order constant for all the participants. The most familiar word in each list was used as a lure word, as is typical in false memory studies (e.g., Smith et al., 2000). The lists of words were recorded in a female voice and presented via headphones connected to a PC/AT compatible computer, which determined the rate of the presentation.

**Design:** The experiment was divided into study and test phases. As shown in Figure 1, three conditions related to study-phase length. In the word-

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**Figure 1.** Schematic representation of the sequential presentation of auditory words in the word-delay, list-delay, and baseline conditions. List words were presented during the filled segments. Under the word-delay condition, 15 words were presented with an SOA of 2 seconds. Under the list-delay and baseline conditions, 15 words were presented with an SOA of 1.3 seconds. During the open segments, 2 seconds (in the word-delay and baseline conditions) or 12.5 seconds (in the list-delay condition) of intervals were inserted. Each condition contained 10 lists, resulting in 320 seconds of the word-delay and list-delay conditions, and 215 seconds of the baseline condition.
delay condition, each word was presented with a stimulus onset asynchrony (SOA) of 2 seconds, resulting in 320 seconds for the study phase. In the list-delay condition, each word was presented every 1.3 seconds, and a blank interval of 12.5 seconds was inserted after presentation of the last word of each list. This also resulted in a study phase of 320 seconds. In the baseline condition, each word was presented every 1.3 seconds, resulting in 215 seconds for the study phase.

We manipulated the length of the study phase for the word-delay, list-delay, and baseline conditions as a between-subjects factor and the type of test as a within-subject factor. This resulted in a $3 \times 2$ factorial design.

Procedure: The participants were tested individually. Participants were instructed to study the words as carefully as possible and told they would be tested later to determine how many words they could remember. After the instruction, the participants put on headphones and began the study phase, preceded by four practice trials. The words used in the practice were not those used in the study or in the practice trials.

For each participant, 10 lists out of the 20 available were randomly chosen for the study phase and another five lists were used as the filler-control words during the test. The words were presented list by list (i.e., 10 lists of 15 words, resulting in 150 items). A female voice prompting, "next list," separated one list from the next. After the study phase, the participants received approximately three minutes of instructions for the test phase.

The test phase consisted of 60 recognition trials. There were four types of trials: 1) studied trials, in which the 1st, 8th, and 10th words in each studied list (3 words $\times$ 10 lists $=$ 30 words) were presented, as in Roediger and McDermott's 1995 study; 2) lure trials, in which the lure words for each studied list (1 word $\times$ 10 lists $=$ 10 words) were presented; 3) the filler-control trials, in which the 1st, 8th, and 10th words in each non-studied list (3 words $\times$ 5 lists $=$ 15 words) were presented; and 4) the lure-control trials, in which the lure-equivalent words for each non-studied list (1 word $\times$ 5 lists $=$ 5 words) were presented. The recognition test was designed so that the four types of trials were randomly mixed. With each presentation of a test word, the participants distinguished whether the word had been previously heard ("old") or not previously heard ("new") during the study phase by pressing corresponding keys of the keyboard ("D" for a "new" response or "A" for an "old" response). The recognition test was self paced and followed by a debriefing.

Results

The average rates of the "old" responses for the four trial types in the word-delay, list-delay, and baseline conditions are shown in Table 1.

Veridical recognition: The average rate of the "old" responses in the two trial types (the filler-control and studied trials) was calculated for each condition of the study phase length. The data were subjected to a 3 (the study phase length as a between-subjects factor) $\times$ 2 (the trial type as a within-subject factor) analysis of variance (ANOVA). The analysis yielded a significant main effect of the trial type, $F(1,45) = 1034.83, p < .01$. Neither the main effect of the study phase length nor the interaction between the two factors was significant.

False recognition: The average rate of the "old" responses for two trial types (the lure-control and

<table>
<thead>
<tr>
<th>Trial type</th>
<th>Baseline</th>
<th>Word-delay</th>
<th>List-delay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Studied</td>
<td>79.6</td>
<td>80.6</td>
<td>78.7</td>
</tr>
<tr>
<td>Filler-control</td>
<td>7.6</td>
<td>8.3</td>
<td>10.4</td>
</tr>
<tr>
<td>Lure</td>
<td>49.4</td>
<td>61.3</td>
<td>65.6</td>
</tr>
<tr>
<td>Lure-control</td>
<td>23.8</td>
<td>15.0</td>
<td>12.5</td>
</tr>
<tr>
<td>Corrected rate</td>
<td>25.6</td>
<td>46.3</td>
<td>53.1</td>
</tr>
</tbody>
</table>
lure trials) was also calculated for each condition of the study phase length. An ANOVA yielded a significant main effect of trial type, \( F(1, 45) = 154.24, p < .01 \), and the interaction, \( F(2, 45) = 6.01, p < .01 \). The significant main effect of trial type indicated that the lure words were more likely to be falsely recognized than the control words. The significant interaction suggests that the difference across study phase length conditions was larger for lures compared with controls (49.4, 61.3, and 65.6 for the baseline, word-delay, and list-delay conditions, respectively, under the lure conditions, relative to 23.8, 15.0, and 12.5, respectively, under control conditions). The main effect of the study phase length was not significant.

To consider the difference in the lure-control conditions (23.8% in the baseline, 15.0% under the word-delay conditions, and 12.5% under the list-delay conditions), we calculated corrected false recognition rates by subtracting the rate of the "old" responses to the lure-control from the "old" responses to the lure trials. This procedure is common in studies of false memory (e.g., Seamon et al., 1998). The corrected false recognition rates are also shown in Table 1. An ANOVA using these data yielded a significant main effect of the study phase length, \( F(2, 45) = 6.10, p < .01 \). Further analysis showed that the corrected false recognition rate increases when the study phase lengthens. False recognition rates under the two conditions in which the length of the study phases were extended (the word-delay and list-delay conditions) were higher than the rates under the baseline conditions, \( t(45) = 2.55 \) and 3.34 for word-delay vs. baseline and list-delay vs. baseline, respectively. Moreover, the difference between the two delay conditions was not significant.

**Discussion**

This study investigated how study-phase length affects false recognition in the auditory domain. Specifically, we examined whether the amount of auditory false recognition increased when the length of the study phase was extended.

This study revealed two major findings. First, lure words were more likely to be falsely recognized compared with control words, demonstrating a typical false recognition effect. Second, and more importantly, inserting a delay either between the words or between the lists of words was sufficient to increase the amount of false recognition. Thus, the corrected false recognition rates under the word-delay condition or under the list-delay condition was higher than those under the baseline condition. These results indicate that extending the length of the study phase increases false recognition not only in the visual domain but also in the auditory domain, regardless of how the study phase was extended (i.e., by insertion of blank period after each word or each list).

These results demonstrate that false recognition increased in the auditory domain when the study phase was lengthened. The effect was comparable regardless of the way in which we extended the study phase (i.e., inserting an extra interval either between the words or between the lists). Previous studies that presented words visually (e.g., Arndt & Hirshman, 1998; Seamon et al., 1998) have used a similar word-delay procedure by extending the duration of a word. In the present study, we showed increases in false recognition not only by inserting extra space between the words but also by inserting space between the lists of words. This finding indicates that extending the study phase length generally increases false recognition regardless of the procedure by which the study phase length is extended.

Based on the present finding that extending the study phase length increases auditory false recognition, we argue that this effect is due to activation of the semantic association between lists and lure words during blank intervals. Under the word-delay and list-delay conditions, participants were given extra retention time compared with those in the baseline group. This additional time allowed participants to rehearse the presented list words, resulting in the activation of a lure word related to the list. The fact that there was no difference in the rate of false recognition between the word-delay and list-delay conditions also indicates that allowing participants extra time for rehearsal increases false recognition, regardless of the method of adding time. The more
retention time a participant had, the more likely he or she was to activate a lure word. Our results are consistent with other research in suggesting that the increase in false memory is mediated by the activation of semantic association between list and lure words (McDermott, 1996; Payne et al., 1996).

In summary, this study extends the knowledge of mechanisms in relation to the effect that the study phase length has on false recognition. We have demonstrated that false recognition increases when the length of the study phase is extended not only in the visual domain (e.g., Arndt & Hirshman, 1998), but also in the auditory domain. According to these results, the process of semantic activation common to different modalities mediates the effect of study phase length on false recognition.

References
—Received Sep. 30, 2004; Accepted Jul. 12, 2005—