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Backward associative strength and illusory recollection : extension of the source-strength effect to item location

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BACKWARD ASSOCIATIVE STRENGTH AND ILLUSORY RECOLLECTION: EXTENSION OF THE SOURCE-STRENGTH EFFECT TO ITEM LOCATION

BY

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B.S., Psychology, Tulane University, 2001
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Submitted in Partial Fulfillment of the
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ABSTRACT

When a false memory contains detailed information about an event that never occurred it is called an illusory recollection. Previous experiments demonstrated that the contextual characteristics of studied words are attributed to false memories of nonstudied theme words. Additionally, contextual characteristics of the studied items that are most highly associated to a theme word are more often attributed than those of lower associates. The finding that the critical theme word takes on the contextual characteristics of its strongest associates was aptly named the source-strength effect. In two experiments, the source-strength effect is extended to word location independent of encoding instructions and of an inference strategy. The study sets the stage for future research asking how source representations are encoded or retrieved for falsely-remembered items.

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Chapter 1

Introduction

Sometimes we think we experienced an event that never actually happened. Many conditions can lead someone to report a false memory, for example, repeatedly imagining an event or being presented with additional post-event information. Sometimes false memories can include memorial details, further convincing us that the event did occur. When false memory is the result of associative semantic processing, remembering specific details of the experience of the event is called illusory recollection (see Gallo, 2006, for a review).

Early false memory research focused on associative influences on false remembering. At that time, it was realized that participants would intrude related ideas, but researchers could not reliably predict what words would be intruded. In 1959, Deese observed reliable, predictable extralist intrusions using single-trial free recall. Whereas Deese demonstrated false memory effects on recall memory tests, Underwood showed these effects on recognition tests (1965). Underwood had participants study long lists of repeated associated words. In a recognition test, he found that the semantically-related words were more likely to be falsely recognized than new unrelated items, emphasizing the idea that the strength of the associative connections between studied words and their associated lures influence false recognition.

The DRM Paradigm

The experimental method used by Deese in 1959 was later revived by two experimenters, Henry L. Roediger, III and Kathleen B. McDermott (1995). Deese's original experiment used study lists consisting of the 12 strongest associates to a nonstudied stimulus word. Studied lists were based on free-association norms created by giving participants lists of stimulus words (e.g., “sleep”) and instructing participants to report the first word that came to mind in response to each stimulus word (e.g.,“bed”, “pillow”, or “tired”; Russell & Jenkins, 1954). Deese reported that individuals often falsely recalled the nonstudied stimulus word.

In 1995, Roediger and McDermott published multiple experiments replicating and extending Deese’s findings. They found high levels of false recall and false recognition of the nonstudied stimulus word (also referred to as the critical theme word) using Deese’s original 12-word lists and 12 additional lists they constructed. Most importantly, Roediger and McDermott reported that false memories of theme words could not be differentiated from true memories of studied words based on confidence judgments. This revised and revived experimental procedure, which takes advantage of associative relationships among stimuli, is now referred to as the Deese-Roediger-McDermott, or DRM, paradigm.

The direction and strength of the association between studied and critical theme words influences the likelihood of false memory. Association strength can be categorized in two ways: backward associative strength (BAS) and forward associative strength (FAS). A studied word’s BAS corresponds to the probability that the critical theme word is generated when the studied word is presented as the stimulus. For example, the probability that the list word “bed” elicits the stimulus word “sleep” is .638 (Nelson, McEvoy, & Schreiber, 1998). Alternatively, a studied word’s FAS denotes the probability that it is generated when the critical theme word is presented as the stimulus word. For example, the probability that the stimulus word “sleep” elicits the list word “bed” is .092 (Nelson, McEvoy, & Schreiber, 1998).

Roediger, Watson, McDermott, and Gallo (2001) examined seven properties of critical theme words or study list words that might predict false memory including the type of association, BAS and FAS. The three critical theme word variables were the word length (the number of letters in each critical theme word), raw frequency (the number of times a critical theme word is found in print per million words), and concreteness ratings (based on a scale of 1-7, and as obtained from the word association norms of Nelson, McEvoy, and Schreiber, 1998). The four variables of list words were the FAS, BAS, inter-item associative strength (connectivity between word pairs within lists), and veridical recall (average probability of recall of the studied words). In their multiple regression analysis, BAS of studied words was the strongest predictor of false recall relative to the other variables (Roediger et al., 2001).

Illusory Recollection

Subjective judgments of false memories have indicated that false memory is often accompanied by contextual details in the DRM paradigm, a phenomenon called illusory recollection. The presence of contextual details has been demonstrated using the “remember”/”know” procedure. Tulving developed the “remember”/“know” judgment task as a means of distinguishing between two subjective states of remembering (1985). Participants are asked to judge their memory as “remembered” when specific details about the word’s prior occurrence can be recollected. They are asked to judge their memory as “known” when specific details are not remembered, but the participant believes the event occurred earlier. Roediger and McDermott found that participants made “remember” judgments for 53% of the falsely-recognized critical theme words (Experiment 2, 1995), suggesting that critical theme words did not only evoke a feeling of familiarity, but also were consciously recollected as having been experienced.

False recall or recognition of a critical theme word may include contextual details that are consistent with the contextual details encoded with studied items, such as a voice of presentation or visual details of presentation. Past experiments conducted to elicit illusory recollection include presenting each DRM list using two alternating voices (e.g., Payne et al., 1996; Mather et al., 1997) and presenting each DRM list using alternating visual and auditory sources (e.g., Gallo et al., 2001). In many of these experiments, it was demonstrated that source judgments for falsely-remembered critical theme words often matched the voice of the corresponding list (Mather et al., 1997) and often matched the heard or seen condition of the corresponding list (Gallo et al., 2001). The important finding in these studies was that the contextual details attributed to theme words may have been retrieved from or encoded during the study of associated lists, and not from non-associated lists.

The contextual details reported for illusory recollected items can come from semantically similar items. That is, the overlap between the visual and semantic features of a new item and previously studied items seem to influence illusory recollections. Lyle and Johnson (2006) varied the location and color of studied words and pictures as well as the visual and semantic similarity of studied and new items. They found that when imagined objects were falsely remembered, participants tended to report that the objects had appeared in the location in which a similarly shaped or conceptually related object had actually appeared. False memories imported location from memories of seen objects, a process that Lyle and Johnson argue happens at retrieval (2006).

Lampinen, Meier, Arnal, and Leding (2005) questioned the origin of the source details that are “remembered” for critical theme words. In this set of experiments, participants were encouraged to say, out loud, everything they were thinking while they studied eight DRM lists. At test, participants were shown words and asked to make old-new and remember-know judgments while thinking out loud. Lampinen et al. found that for more than one-third of false remember judgments participants had clearly borrowed content from actually presented items and used that content to corroborate their false memories (2005).

The Source-Strength Effect

To address the broad question of which variables influence the illusory recollection of source information for falsely-remembered words, researchers manipulated the relationship between source information for studied words and the strongest predictor of false recall: BAS of studied words. Hicks and Starns (2006) used two equally memorable sources for studied items, visual and auditory. Each of 10 DRM lists was divided into two sub-lists, the strongest six associates and the weakest six associates (i.e., BAS). For each list, one sub-list was presented visually and the other aurally.

In their first experiment, Hicks and Starns (2006) found that when participants attributed any source to a falsely-recognized critical theme word, they were more likely to attribute the source in which the highest-BAS study items were presented. When the auditory source was attributed to falsely-recognized critical theme words, it was more likely to have been the source of the high-BAS items (.56) than the low-BAS items (.39). Likewise, when the visual source was attributed to falsely-recognized critical theme words, the pattern was the same: when high-BAS items were presented visually, falsely-recognized critical theme words had a .31 probability of being attributed to that source. When low-BAS items were presented visually, falsely-recognized critical theme words had a .19 probability of being attributed to that source. The finding that the critical theme word takes on the contextual characteristics of its strongest associates was aptly named the source-strength effect.

The results obtained in Experiment 1 (Hicks & Starns, 2006) demonstrated the source-strength effect when source information from different modalities was presented, in a visual information source and an auditory information source. Previously, an experiment by Hicks and Hancock (2002) had shown the same effect using videotaped presentations of DRM sub-lists by male and female speakers. Hicks and Hancock found that critical theme words were more often attributed to the source that presented the high-BAS list items (.48 probability) than the low-BAS list items (.34 probability).

Previous demonstrations of the source-strength effect have utilized sources that were highly discriminable, for example, when low- and high-BAS items were presented in different modalities (e.g., heard versus seen; Experiment 1, Hicks & Starns, 2006). In addition, the source-strength effect has been found when the source details were very enriched. In the Hicks and Hancock (2002) studies visual, auditory, and social information could be recalled to identify whether the female or male experimenter presented an item. These conditions maximized the likelihood that individuals would be able to recall the specific source of studied words. In these experiments, we tested whether the source-strength effect would be apparent when high- and low-BAS item source was limited to a single modality: visual location source memory.

Encoding and Retrieval Explanations of Illusory Recollection

Although theories of false memory abound, it is not clear whether illusory recollection in associative false memory is due to encoding or retrieval processes. If illusory recollections are due to processing at encoding, possibly the illusory recollection is created because of the binding of source characteristics of associated words to the critical theme word when it is activated (Roediger et al., 2001).

According to the activation/source monitoring theory of false recall, critical theme words from DRM lists are activated at encoding via their backward associations to studied words. This is more likely to happen for the highest-BAS items. Contextual details from studied words become bound to the activated theme word, and because activation is more likely when high-BAS items are studied the high-BAS source information is more likely to become bound to nonpresented critical theme words (Gallo et al., 2001). In this view the source-strength effect is the result of when, during the study phase, the critical theme word is activated and encoded enough to be indistinguishable from studied items.

Another explanation for illusory recollection suggests that at retrieval when critical theme words are falsely remembered the contextual details from studied words are misremembered as part of the false memories. This explanation proposes that experienced events (e.g., studied words) are stored as collections of both semantic and contextual features. Global matching models of recognition memory assume that memory retrieval is performed by matching the features of a test memory probe (an item presented during the recognition test period of an experiment) to the features of all memory traces (traces from the study period of an experiment; e.g., Gillund & Shiffrin, 1984). Activation is computed based on the overlap between the features of the test probe and features of stored memory traces. If activation reaches a threshold level, the test item is considered remembered.

In these models, an illusory recollection is the result of retrieving the memory trace that most closely matches the memory probe and reporting the features associated with that trace. Sometimes the studied item will not have source features encoded with it, though. In this view, source information is more likely to be retrieved from a high-BAS item than a low-BAS item because the high-BAS items share more features with the critical theme word. However, if the source is not available from the studied items' memory trace, the individual must make a guess about source – effectively reducing the source-strength effect.

One way to distinguish between the idea that source information is bound to the critical theme word at encoding and the idea that contextual details from studied words are misremembered as part of memories of the critical theme word as the result of retrieval processes is to examine how the source-strength effect is influenced by varying the binding of source information to the studied item. According to the misbinding-at-encoding account, an encoding manipulation that improves accurate memory for source information should have a similar effect on the processing of both high- and low-BAS studied items. When source information is increased, critical theme words may be less likely to be falsely recognized (Gallo et al., 2001), but the misbinding of source to activated critical theme words at encoding should be influenced by studying high- and low-BAS items similarly. According to the misbinding-at-encoding account, the source-strength effect should be unaffected by an encoding condition that affects source memory for studied items. According to the global matching models, increasing the source memory for studied items should increase the source-strength effect.

The Current Study

The goals of the current study were to: (1) extend the source-strength effect to source information that was less easily distinguishable in memory (two locations), (2) supplement a retrieval account of illusory recollection by manipulating encoding, and (3) determine whether illusory recollection is based on mnemonic evidence. Of interest is whether sources that are not as distinctive, like variation in locations, will lead to a source-strength effect.

We predict that when critical theme words elicited by DRM lists are falsely recognized, they will more often be attributed to the location in which the highest-BAS list words were presented. If the source-strength effect is greater in the intentional encoding condition than in the incidental encoding condition, illusory recollection may be due to processes happening at retrieval. If the source-strength effect is not greater in the intentional encoding condition than in the incidental encoding condition, illusory recollection may be due to processes happening at encoding.

Chapter 2

General Method

In the experiments reported here, we addressed the question of whether two sources from the same modality (i.e., the visual modality) will result in the source-strength effect. Unlike previous experiments testing for the source-strength effect, our experiments utilized word location on a computer screen as the source information (Hicks & Hancock, 2002; Hicks & Starns, 2006). The major differences between Experiment 1 and Experiment 2 are outlined here. In the first experiment, the instructions regarding the encoding of source information were manipulated between subjects, while in the second experiment, encoding of source information was the same for all participants. Another difference between the two experiments addressed the idea that participants might be using a guessing strategy to infer a source for the critical theme word. Thus, Experiment 1 utilized three response options at test (seen earlier on the left, seen earlier on the right, and new) and Experiment 2 utilized four response options at test (seen earlier on the left, seen earlier on the right, seen earlier but do not remember what side, and new).

Participants

University of New Mexico undergraduate students agreed to participate in exchange for course credit or extra credit in Psychology courses. Participants were randomly assigned to the between-subjects condition upon arrival at the laboratory in the Department of Psychology. Participants were tested individually and experimental sessions lasted approximately 30 minutes.

Apparatus

Presentation of stimuli and recording of responses were controlled by E-prime 1.1 computer software (Schneider, Eschmann, & Zuccolotto, 2002) running on a Dell Dimension computer with a 24-inch Sony Trinitron monitor. For the source test, the program collected responses and reaction times.

Materials

Encoding stimuli. Twelve lists of 15 associatively-related words each were chosen from the appendix of Roediger, Watson, McDermott, and Gallo (2001). Ten of these were the lists used by Hicks and Starns (2006): *bread*, *doctor*, *mountain*, *needle*, *rough*, *slow*, *smell*, *sweet*, *trash*, and *window*, and two were added to satisfy a counterbalancing condition: *city* and *king*. The words in each list were arranged from highest to lowest backward associative strength (BAS) to the critical theme word (see Appendix). For each list, the six items with the highest BAS formed the high-BAS sub-list and the six items with the lowest BAS formed the low-BAS sub-list. Across the 12 studied lists, the mean BAS value for all high-strength items was 0.406 and the mean BAS value for all low-strength items was 0.014 (Roediger et al., 2001). For six of the lists the high-BAS items were presented on the left side of the screen and the low-BAS items were presented on the right. The reverse was true for the remaining six lists.

Four groups of lists were created to pseudorandomize study list order, sub-list presentation order (high-BAS sub-list first or low-BAS sub-list first), and source order (left side first or right side first). The 144 items were presented one at a time on a computer screen in 24 point bold Courier New font in white text on a black background to minimize eye strain. Words were centered vertically on the screen but sub-lists were presented on either the left or right side horizontally (Figure 1).

Practice and filler lists were constructed from the normed *car* list (Roediger et al., 2001). During the instruction period, the practice list consisted of the six highest-BAS words. The three highest-BAS words were shown on the left side of the screen followed by the three remaining BAS words shown on the right side of the screen. To decrease the primacy effect, a filler list of six of the lowest-BAS words from the *car* list was presented before the experimental items. For all groups, this six-item filler list was presented on the left side of the screen prior to the 144-item study list.

Source test. The recognition test was composed of 72 new and 48 old items. The new items could be related to studied items or unrelated to studied items. New related items were the three items from positions 7, 8, and 9 of the studied lists (that were not studied) and the critical theme word from each studied list. New unrelated items were one item from each of 12 non-studied lists, and the critical theme word from 12 non-studied lists. In addition to these 72 lures on the source test, studied items from serial positions 2, 5, 11, and 14 were presented. Thus, item types at test were studied items, new unrelated items, new related items, and critical theme words. All participants in all groups received five filler items prior to the test list. The filler items were three new items and two items from the practice study list. These five items served as practice for the test procedure and were not included in analyses. The five filler items and then the 120 test items were presented in the middle of the computer screen vertically and horizontally (Figure 1). The test sequence of 120 test items was randomized anew for each participant.

Procedure

Participants were seated in front of a computer monitor in a quiet room and were instructed that they would be studying lists of words for a subsequent memory test.

Participants read instructions as an experimenter observed and answered any questions. After the practice list was presented, the experimenter answered any remaining questions and expressly told participants to be as accurate as possible when they completed the memory test, rather than as quick as possible.

The six filler items and the 144 studied items were presented at a 2-s rate. A 500-ms blank screen separated one study trial from the next. When the study list was complete, participants were given multiplication problems to solve for three minutes as a distracter task. The source test instructions were then presented. In Experiment 1, participants had three response options (Figure 1b), while in Experiment 2, participants had four response options (Figure 1c). As in Hicks and Starns (2006), participants were told to carefully consider their decisions because some of the new items on the test were similar in meaning to studied items.

After completing the encoding portion, the delay task, and the source test, participants completed an information sheet that asked about medications they were taking, handedness, and primary language spoken.

Data Analysis

In item analyses, we counted as recognized any studied item given a source claim, regardless of whether the source claim was correct. We first analyzed correct recognition of studied items. To evaluate objective memorability differences between the source alternatives, we compared differences in the proportion of recognized items from each source. We then analyzed false recognition of new items.

In analyses of source attributions for studied items, we divided the number of correct source attributions by the number of items correctly recognized in a given source.

We chose to conditionalize because we are interested in the processes underlying source attributions.

In analyses of source attributions for critical theme words and other new related items, we divided source attributions by the number of items with corresponding high-BAS sub-lists presented in a given source. The analyses of interest focused on source attributions to critical theme words. We also analyzed the proportion of new related and new unrelated items attributed to each source.

Hypothesis tests were performed with a Type I error probability of .05 to define statistical significance.

Chapter 3

Experiment 1

The purpose of the first experiment was to determine whether the source-strength effect would differ when the amount of source information encoded with studied items was manipulated. We attempted to manipulate the amount of source information encoded with studied items by varying the encoding instructions to participants. To preview, this manipulation was not successful.

In all of the previous work, individuals were not aware that their memory for the source of the information was going to be tested. The natural processing tendency of the individual in this situation, when studying lists of associated material for long-term retention, is to focus on the semantic content and relationships between words rather than on the source-specifying details. Poor binding of source information to studied items may result.

Processes happening at encoding may influence memory for source information. Although the encoding of source information has been described as “automatic” (Hasher & Zacks, 1979), these descriptions were based on object location memory. When participants are told that they will be tested on their memory for words, they often utilize effortful processes and employ a memory strategy that they believe is best (e.g., imagery, rehearsal, etc.) (Reisberg, 2009). Memory for words and individual word locations may not differ whether participants are told to remember location or not. However, semantic false memories may be given source attributions more often when attention is focused on source information for words during encoding. And, we hypothesized that these source attributions would more often based upon high-BAS source due to semantic relationships.

To increase how much source information was bound to studied items, participants were explicitly instructed to pay attention to contextual details during encoding. Intentional encoding instructions have been shown to be ineffective in improving memory for studied items in part because individuals do not process the items more effectively under intentional instructions. Source memory may be affected differently, though. Intentional source memory instructions direct individuals' attention to the source-specific information during study and thus might be effective for improving source memory.

To manipulate source encoding, half of the participants were given incidental source encoding instructions and the other half were given intentional source encoding instructions. In the incidental source encoding condition, participants were told to remember the words for a future memory test. In the intentional source encoding condition, participants were told to remember the words and the locations of the words for a future memory test.

Our conclusions were contingent upon finding different source memory in the encoding conditions. If the source-strength effect is greater in the intentional encoding condition, we postulated that it may be because source information is more likely to be available from the studied memory traces and thus attributable to retrieval of high-BAS studied item source information at test. However, our manipulation of encoding condition did not succeed in producing a difference in source memory between groups.

Method

Participants. Seventy-one University of New Mexico undergraduate students agreed to participate in exchange for course credit or extra credit in Psychology courses.

Seven participants were excluded because they were not native English speakers. Three participants were excluded due to prior knowledge of or experience with the DRM paradigm. Two participants were excluded for taking medications affecting cognition. Two participants were excluded for being outside the age range of 18-30 years. Three participants were excluded for failure to follow instructions. Two participants were excluded for low accuracy (less than the criterion of .40, which is two standard deviations below the mean accuracy of .71). This left 52 participants (35 female, mean age = 20.02 years) whose data were included in the analyses, with equal groups of 26 in each encoding condition.

Source test. Due to a programming error in the source test, only 105 random test items were presented to 49 participants and all 120 test items were presented to three participants. The proportions of different item types remained as planned: critical theme words were .10 of trials, new unrelated items were .20 of trials, new related items were .30 of trials, and studied items were .40 of trials. Participants were told to decide whether each test item had been studied or not. If a word was new, participants pressed the B key on the keyboard. If the word had been studied, participants were instructed to press the F key if it had been studied on the left side of the screen or to press the J key if it had been studied on the right side of the screen. Keys were marked with adhesive labels “N”, “L”, and “R” for these response options (Figure 1b).

Procedure. The general procedures described in the previous section were followed except for the following. Participants in the incidental encoding condition were told that they would be tested on their memory accuracy for studied words. Participants in the intentional encoding condition were told that they would be tested on their memory accuracy both for the words and for the locations where the words were presented on the screen during study.

The source test instructions requested participants to decide the source of each test item by deciding whether the item had been studied on the left or right or whether the item was new.

Design. The design was a 2 (encoding condition) x 2 (associative strength) x 2 (source) mixed factorial. Encoding condition was manipulated between subjects and the latter two factors were manipulated within subjects. The dependent variable was proportion of falsely-recognized critical theme words attributed to the source in which its high associates were presented.

Results

Results concerning overall recognition will be presented first, followed by source attributions. Trials with response latencies greater than 10,000 ms and less than 300 ms (0.908% of all trials) were excluded from the analyses.

Correct recognition of studied items. Items given a left or right attribution were counted as correct recognition responses, regardless of the accuracy of the source judgment. The mean proportion of correctly recognized studied items was .709 (SE = .020) across groups. A three-way mixed measures ANOVA with BAS (high versus low) and studied location (left versus right) as within subjects variables and encoding condition as a between subjects variable (incidental versus intentional) was conducted on the mean item accuracies of the studied items. As can be seen in Figure 2, a significant main effect of BAS revealed that participants remembered high-BAS studied items (M = .702, SE = .021) better than on low-BAS items (M = .614, SE = .024), $F(1,50) = 8.118$, p

$< .01$. Studied item accuracy for low-BAS and high-BAS items did not differ between the incidental source encoding condition ($M = .717$, $SE = .029$) and the intentional source encoding condition ($M = .700$, $SE = .030$), $F(1,50) = 0.552$ (Figure 2). Unexpectedly, the main effect of studied location (left: $M = .620$, $SE = .021$; right: $M = .696$, $SE = .025$) was significant, $F(1,50) = 5.355$, $p < .05$. Additionally, the interaction of BAS and location showed the difference between correct recognition of high-BAS items studied on the left ($M = .645$, $SE = .032$) and on the right ($M = .759$, $SE = .027$) was significantly greater than the difference between correct recognition of low-BAS items studied on the left ($M = .596$, $SE = .029$) and on the right ($M = .633$, $SE = .034$), $F(1,50) = 2.163$, $p < .05$. The interactions of BAS and encoding condition ($F(1,50) = 0.552$) and location and encoding condition ($F(1,50) = 0.248$) were not significant.

False alarms to new items. A two-way mixed measures ANOVA with item type as the within subject variable (critical theme word, new related item, or new unrelated item) and encoding condition as the between subjects variable (incidental versus intentional) was conducted on the mean proportion of falsely-recognized items. False recognition of new item types did not differ between encoding condition (incidental: $M = .388$, $SE = .030$; intentional: $M = .386$, $SE = .030$), $F(1,50) = 1.725$ (Figure 2). As expected, a significant main effect of item type was found, $F(2,52) = 328.308$, $p < .001$. As can be seen in Figure 2, false recognition of theme words ($M = .703$, $SE = .027$) was greater than false recognition of new related items ($M = .308$, $SE = .024$) which was greater than false recognition of new unrelated items ($M = .150$, $SE = .022$).

Source attributions for studied items. Source memory accuracy was calculated separately for high- and low-BAS items presented in the left and right locations. Source accuracy was determined by dividing the number of correct source claims by the total number of recognized items from that source. Table 1 displays source memory accuracy for studied items by encoding condition, BAS, and location.

A three-way mixed measures ANOVA with BAS (high versus low) and studied location (left versus right) as within subjects variables and encoding condition (incidental versus intentional) as a between subjects variable was conducted on the mean source accuracies of the studied items. A significant main effect of BAS revealed that participants' source memory for high-BAS studied items (M = .544, SE = .022) was better than source memory performance for low-BAS items (M = .393, SE = .018), $F(1,50) = 38.074$, $p < .001$. The main effect of location (left: M = .449, SE = .020; right: M = .488, SE = .020) was not significant, $F(1,50) = 2.486$. The interactions of BAS and encoding condition ($F(1,50) = 0.630$), location and encoding condition ($F(1,50) = 0.027$), and BAS and location ($F(1,50) = 0.580$) were not significant.

Source attributions for falsely-recognized items. Table 2 displays the proportion of falsely-recognized critical theme words that were attributed to each study location and corresponding BAS condition for each encoding condition. To evaluate whether a source-strength effect was observed, the proportion of critical theme words that were falsely recognized and attributed to high-BAS locations was calculated for each encoding condition. Results are presented in Figure 3. Collapsing across encoding conditions, the proportion was significantly greater than would be expected according to chance (.50), $t(51) = 4.778$, $p < .001$ (high-BAS source attributions: M = .633, SE = .028). This source-strength effect corresponds to a large effect as measured by Cohen's r (.556, Cohen, 1992). The proportion of falsely-recognized critical theme words attributed to the high-BAS location did not differ between the two encoding conditions according to an independent samples t-test, $t(50) = -0.155$ (incidental: $M = .629$, $SE = .042$; intentional: $M = .638$, $SE = .037$).

To examine whether a bias existed for one location attribution over the other for critical theme words (as was observed for studied items), we conducted a two-way mixed measures ANOVA with location attribution (left versus right) as a within subjects variable and encoding condition as a between subjects variable (incidental versus intentional) on the proportion of falsely-recognized critical theme words attributed to that location when the high-BAS studied items were presented in it. There was a small difference (approaching significance) in the tendency to attribute falsely-recognized critical theme words to the high-BAS location when the high-BAS studied items were presented on the left ($M = .588$, $SE = .041$) versus on the right ($M = .668$, $SE = .035$), $F(1,50) = 2.889$, $p = .095$. Additionally, the interaction of location attribution and encoding condition approached significance ($F(1,50) = 3.838$, $p = .056$): in the incidental encoding condition, critical theme words were called “left” when corresponding high-BAS items were on the left ($M = .628$, $SE = .057$) about as often as they were called “right” when corresponding high-BAS items were on the right ($M = .616$, $SE = .050$), but in the intentional encoding condition, critical theme words were called “left” when corresponding high-BAS items were on the left ($M = .549$, $SE = .057$) less often than when they were called “right” when corresponding high-BAS items were on the right ($M = .721$, $SE = .050$).

Aside from critical theme words, the proportion of new related items that were falsely recognized and attributed to high-BAS locations ($M = .567$, $SE = .031$) differed significantly from chance as well, $t(51) = 2.075$, $p < .05$ (Figure 3). This difference represents the source-strength effect and corresponds to a medium effect size, Cohen's $r = .279$ (Cohen, 1992).

To test for a difference between encoding conditions in the proportion of falsely-recognized new related items attributed to the high-BAS location, an independent samples *t*-test was performed and a difference was not found ($t(50) = -0.703$; incidental: $M = .542$, $SE = .038$; intentional: $M = .586$, $SE = .049$) (Figure 3). To examine whether new related items showed a bias for one location attribution over the other in the intentional encoding condition but not the incidental encoding condition, we conducted a two-way mixed measures ANOVA with location attribution (left versus right) as the within subjects variable and encoding condition (incidental versus intentional) as the between subjects variable on the mean falsely-recognized new related items attributed to the corresponding high-BAS location. A main effect of location was found: "right" source attributions for items where corresponding high-BAS items were presented on the right ($M = .624$, $SE = .039$) were greater than "left" source attributions for items where corresponding high-BAS items were on the left ($M = .517$, $SE = .043$), $F(1,47) = 4.396$, $p < .05$. The interaction of condition and location attributions was not significant ($F(1,47) = 2.161$).

False recognition of new unrelated items was minimal across both encoding conditions: $M = .150$, $SE = .022$. The proportion of falsely-recognized new unrelated items was submitted to an independent samples *t*-test, and no difference was found between the incidental encoding condition ($M = .175$, $SE = .035$) and the intentional encoding condition ($M = .126$, $SE = .028$), $t(50) = 1.089$.

Discussion

Experiment 1 showed that when critical theme words were falsely recognized participants were more likely to choose the source in which corresponding high-BAS items were presented than would be expected if they were guessing. The resulting source-strength effect replicated the effect found in earlier studies (Hicks & Hancock, 2002; Hicks & Starns, 2006).

One unique result of our first experiment was that the source-strength effect carried over to new related items (Figure 3). In fact, the lack of a source-strength effect for new related items was argued as a reason that "a simple semantic relationship to the list theme does not cause the [source-strength] effect" and that "the critical item is unique" (Hicks & Hancock, 2002). Our results show that a semantic relationship to the list theme does, in fact, cause the source-strength effect.

Even in correct recognition of studied items, we found that participants remembered high-BAS studied items better than low-BAS items (Figure 2). This finding suggests that items that are highly associated to the theme word are encoded better than items that are only weakly related to the theme word. This difference was similar in both encoding conditions, and was the only bias in source memory for studied items across conditions.

Our manipulation of encoding condition did not produce a difference in the source-strength effect, nor did it produce a difference in correct attributions to studied items. We hypothesized that an intentional source encoding condition would increase how much source information was bound to studied items because attention to source-specific information during study, and that "extra" source information would be available from the studied memory traces during the recognition test. However, our manipulation failed to produce a difference between groups.

Participants may have had an overall bias for the right location over the left. First, in both encoding conditions, participants favored the right side when attributing a critical theme word to a high-BAS location. Second, illusory recollections with high-BAS source attributions to critical theme words occurred more often for the right and less often for the left in the intentional encoding condition than in the incidental encoding condition. Finally, illusory recollections with high-BAS source attributions for new related items occurred more often for the right side across both conditions. Our explanation for these trends is that participants tended to employ a guessing strategy more often in the intentional encoding condition, and utilized the “right” source attribution more often as the guessed source. One possibility for this bias could be that participants tended to use their dominant hand to make their responses when they were unsure, and because 87% of the participants were right-handed this led to more frequent right-sided guesses.

In this first experiment, then, we demonstrated a large source-strength effect using item location information as the source. Previous demonstrations of the source-strength effect utilized sources that were highly discriminable or very enriched; the sources used here to demonstrate the effect are impoverished and do not maximize the likelihood that individuals might recall the specific source of studied words.

One concern with this experiment is that participants were forced to attribute a source to the critical theme words. Therefore, the source attributions participants made to critical theme words might have been guesses rather than judgments based on the retrieval of source-specific information. Experiment 2 was designed to replicate the source-strength effect with location sources and to reduce the influence of the participants' bias (possibly towards the right side). To do this we decided to test whether a source-strength effect would persist even with a "do not remember source" option at test. If the source-strength effect persists, we may conclude the effect is not based on a guessing strategy, and that source evidence for falsely-recognized items is available to participants as they make informed decisions based on previously-encoded illusory recollections.

Chapter 4

Experiment 2

In Experiment 1, it was not necessarily the case that the participants were making source attributions to the high-BAS side because they had illusory recollections of source information for them. Because participants could only choose “left” or “right” when making a source decision for any item, it is possible that the source-strength effect seen in Experiment 1 resulted from participants guessing a response.

We conducted Experiment 2 in order to determine whether the source-strength effect would persist even when the option of “do not remember source” was available. Such a finding would be consistent with a memory-based account of illusory recollection. With a “do not remember source” response available, participants are likely use this response when a source judgment cannot be based on mnemonic evidence, and are probably less likely to engage in a guessing procedure. In this second experiment, then, participants chose whether test items were presented earlier in one of two sources, presented earlier but “do not remember source”, or not presented earlier. The source-strength effect persisted even with our addition of the additional response option at test.

In Experiment 1, the source-strength effect did not differ when participants were told to remember source information versus when they were not told to remember source information. In order to focus on the broader question of whether the source-strength effect is observable for highly similar sources like locations (when source information may not be retrieved at all), we decided to not include this variable in the design of Experiment 2.

Method

Participants. Seventy-eight University of New Mexico undergraduate students who had not participated in Experiment 1 agreed to participate in exchange for course credit or extra credit in Psychology courses. Seven participants were excluded because they were not native English speakers. Ten participants were excluded due to prior knowledge of or experience with the DRM paradigm. Two participants were excluded for taking medications affecting cognition. Five participants were excluded for failure to follow instructions. One participant was excluded for low accuracy (less than the criterion of .43, which is two standard deviations below the mean accuracy of .73). This left 53 participants (38 female, mean age = 19.64 years), whose data were included in the analyses.

Source test. All 120 test items were presented to all participants. Participants were told if they remembered a test item as having been studied to decide the source of each item as studied on the left, studied on the right, or studied earlier but do not remember source. If the item was not recognized from the study period, the participants were instructed to indicate that the item was new. Adhesive labels “L”, “R”, “K”, and “N” were affixed to the F, J, Y, and B keys, respectively, for these decisions (Figure 1c).

Procedure. The general procedures described in the General Method section were followed. All participants were given incidental source encoding instructions from Experiment 1; they were told that they would be tested on their memory accuracy for studied words.

Design. The design was a 2 (associative strength) x 2 (source) mixed factorial. Both factors were manipulated within subjects. The dependent variable was proportion of falsely-recognized critical theme words attributed to the same location as the studied high associates.

Results

Results concerning overall recognition will be presented first, followed by source attributions. Trials with response latencies greater than 10,000 ms and less than 300 ms (1.09% of all trials) were excluded from analyses.

Correct recognition of studied items. Items given a left, right, or "do not remember source" attribution were counted as correct recognition responses, regardless of the accuracy of a source judgment. The mean proportion of studied items correctly recognized was .728 (*SE* = .016). A two-way repeated measures ANOVA with BAS (high versus low) and studied location (left versus right) as variables was conducted on the mean item accuracies of the studied items. As can be seen in Figure 4, a significant main effect of BAS revealed that participants performed better on high-BAS studied items (M = .771, SE = .017) than on low-BAS items (M = .685, SE = .019), $F(1,52)$ = 26.806, $p < .001$. The main effect of location (left: M = .721, SE = .016; right: M = .735, SE = .020) was not significant, $F(1,52) = 0.610$. The interaction of BAS and location was not significant ($F(1,52) = 0.432$).

False alarms to new items. A one-way repeated measures ANOVA with item type (critical theme word, new related item, or new unrelated item) as the variable was conducted on the mean proportion of falsely-recognized items. As expected, a significant main effect of item type was found, $F(2,51) = 132.332$, $p < .001$. As can be seen in Figure 4, false recognition of theme words (M = .684, SE = .028) was greater than false recognition of new related items (*M* = .375, *SE* = .030) which was greater than false recognition of new unrelated items (*M* = .256, *SE* = .020).

Source attributions for studied items. Source memory accuracy was calculated separately for high- and low-BAS items presented in the left and right locations. Source accuracy was determined by dividing the number of correct source claims by the total number of recognized items from that source (including "left", right, and "do not remember source" responses). Table 3 displays source memory accuracy for studied items by BAS and location.

A two-way repeated measures ANOVA with BAS (high versus low) and studied location (left versus right) as variables was conducted on the mean source accuracies of the studied items. A significant main effect of BAS revealed that participants' source memory for high-BAS studied items (*M* = .503, *SE* = .024) was better than source memory performance on low-BAS items (*M* = .450, *SE* = .023), $F(1,52) = 5.854$, $p < .05$. The main effect of location (left: *M* = .462, *SE* = .023; right: *M* = .493, *SE* = .024) was not significant, $F(1,52) = 0.977$. The interaction of BAS and location approached significance ($F(1,52) = 3.788$, $p = .057$) indicating the difference between the sources of high-BAS items correctly identified was larger (left: *M* = .466, *SE* = .029; right: *M* = .540, *SE* = .030) than the difference for low-BAS items (left: *M* = .461, *SE* = .029; right: *M* = .440, *SE* = .030).

Source attributions for falsely-recognized items. Table 4 displays the proportion of responses (e.g., "left", "right", "do not remember source") for falsely-recognized critical theme words and corresponding BAS condition. However, to evaluate whether a source-strength effect was observed for critical theme words or new related words, the number of falsely-recognized items of that type attributed to high-BAS locations was divided by the number of falsely-recognized items of that type attributed to either location. This proportion is presented in Figure 5. The proportion of critical theme words that were falsely recognized, given a source attribution, and attributed to the high-BAS location was significantly greater than would be expected according to chance, $t(51) = 4.032$, $p < .001$ (high-BAS source attributions: $M = .650$, $SE = .037$). This source-strength effect corresponds to a large effect size, Cohen's $r = .488$ (Cohen, 1992).

To examine whether a bias existed for one location attribution over the other for critical theme words, we conducted a paired-samples *t*-test comparing the proportion of falsely-recognized critical theme words attributed to the location in which the corresponding high-Bas items were studied (left or right). There was no difference in the tendency to attribute a high-BAS location when the corresponding list's high associates were presented on the left ($M = .396$, $SE = .034$) or on the right ($M = .433$, $SE = .045$), $t(50) = -0.762$.

Aside from critical theme words, the proportion of new related items that were falsely recognized and attributed to high-BAS locations did not differ significantly from chance ($t(49) = 0.805$; high-BAS source attribution: $M = .528$, $SE = .035$). Thus, a source-strength effect for new related items was not found (Figure 5).

To examine whether new related items showed a bias for one location attribution over the other for new related items, we conducted a paired-samples *t*-test with location attribution (left versus right) on the mean falsely-recognized new related items attributed to the corresponding high-BAS location. The main effect of location was not significant (right attributions for corresponding high BAS right side: *M* = .105, *SE* = .013; left attributions for corresponding high BAS left side: *M* = .117, *SE* = .017), $t(52) = -0.772$).

False recognition of new unrelated items was minimal: *M* = .256, *SE* = .020. The proportion of falsely-recognized new unrelated items was submitted to a paired-samples *t*-test, and no difference was found between left source attributions (*M* = .022, *SE* = .009) and right source attributions (*M* = .024, *SE* = .009) ($t(52) = -0.179$).

Discussion

The results of Experiment 2 replicated those of Experiment 1. Even when participants were allowed to indicate that no source information was recallable for a falsely-recognized word, the source-strength effect was observed. We showed that the source-strength effect is not due to a guessing strategy: even with the option of “do not remember source” at test, participants more often attributed falsely-recognized critical theme words to the source in which corresponding high-BAS items were presented. Although the source-strength effect was not as large as what was found in Experiment 1, it was still large by Cohen’s standards (.488, Cohen, 1992).

Participants demonstrated better item accuracy for high-BAS items than for low-BAS items. This finding suggests that items that are highly associated to the theme word were encoded better than items that were only weakly related to the theme word, even when a third option of “do not remember source” was available. Despite the “do not remember source” response option, we found a small bias for the right side for high-BAS items: the source of high-BAS items presented on the right side tended to be correctly identified more often than high-BAS items presented on the left side. As in Experiment 1, we believe this bias is due to a majority (94%) of the participants being right-handed and more often making right-side location attributions for studied items.

All participants in Experiment 2 viewed 120 test items (12 critical themes, 24 new unrelated, 36 new related, and 48 studied items). Thus, any variance found in the 105-item source test for Experiment 1 was removed. Since each critical theme word and all new related items were presented to each participant, everyone had the same number of instances from each list, and therefore saw the same number of studied and new related items per theme list. This is an important aspect because we know processes are happening during both encoding and retrieval in the phenomenon of illusory recollection (Roediger, et. al., 2001) and individual items on the source test might affect which memory traces are accessed.

The most important result from Experiment 2 is that we demonstrated that the source-strength effect persists even when participants have the option to claim they do not have memory of source information for an item. Thus, participants are not simply using a guessing strategy when attributing sources to critical theme words, a finding that is consistent with a memory-based model of illusory recollection and serves as another piece of evidence for the misbinding-at-encoding account.

Chapter 5

Summary and Concluding Discussion

Source memory refers to “a variety of characteristics that, collectively, specify the conditions under which a memory is acquired (e.g., the spatial, temporal, and social context of the event; the media and modalities through which it was perceived)” (Johnson, Hashtroudi, & Lindsay, 1993, p. 3). It is believed that illusory recollection involves an attribution process where details come from another source and are misattributed to the false memory. This often occurs when misremembering the experience of a related word in the DRM paradigm, where the critical theme word is processed more fluently than new, unrelated words. It is this fluency, then, that causes people to misattribute borrowed or imagined perceptual details from actual presentation (Gallo, 2006).

Previous research using the DRM paradigm has shown that critical theme words take on the contextual characteristics of their strongest associates (the source-strength effect; Hicks & Hancock, 2002; Hicks & Starns, 2006). However, these researchers used highly discriminable or enriched sources, maximizing the likelihood that participants could recall the source of studied items due to distinctive encoding contexts for each list or sub-list. Since recognition of DRM list words relies on semantic associations, individuals are more likely to utilize a broad, semantically-based recognition criterion than when distinctive perceptual information is available (see Arndt & Reder, 2003, for a review). We argued that locations on the left and right side of the computer screen are less discriminable sources than videotaped males versus females, text versus auditory presentation, or text versus pictorial information (Hicks & Hancock, 2002; Hicks & Starns, 2006).

Our research demonstrates the source-strength effect for item location information: when participants falsely-remembered critical theme words, they attributed the locations of each theme word's corresponding high-BAS sub-list significantly more often than its low-BAS sub-list. This is an important finding because sometimes the *lack* of a detailed memory for a nonstudied word provides participants with reasonable evidence that the item was not presented at study (Strack & Bless, 1994). We believe our participants had detailed memories of falsely-remembered critical theme words, and because BAS is the best predictor of false memories (Roediger et al., 2001) the encoding of these "memories" was based on semantic association processes that were greater while studying corresponding high-BAS sub-lists.

The source-strength effects found in Experiment 1 (r = .556) and Experiment 2 (r = .488) are comparable to previously-reported source-strength effects. In the previous research, however, one-sample t-tests were not used to compare source attributions to chance, thus we have reported source-strength effects as the proportion of attributions to the high-BAS side in Table 5.

We found the same source-strength effect whether participants incidentally or intentionally encoded source information (Experiment 1). Our intentional manipulation of source encoding was not effective using location information as the source. Additionally, this encoding manipulation did not have an effect on accurate source memory. Perhaps this lack of effect was *because* location information is harder to discriminate.

The source-strength effect persisted even when participants were given the option to forego making any source attribution (Experiment 2). That is, even with a “do not remember source” option, participants attributed the corresponding high-BAS source to falsely-recognized critical theme words. This finding is consistent with a memory-based account of illusory recollection because individuals did not use decision processes (i.e., a guessing strategy) when making source attributions for critical theme test items. Our results provide further evidence that perceptual features encountered at encoding can become associated with critical theme word item representations, despite the fact that these theme words are never visually perceived during study.

Theoretical Perspectives and Implications

A retrieval-based account of illusory recollection maintains that contextual details from studied words are misremembered and attributed to associated critical theme words at retrieval. In this account each studied item is encoded as a collection of both semantic and contextual features. When a studied item is presented during a recognition test, a matching process commences between the semantic and contextual features of the test item and memories for studied items. If a threshold of a match (for both semantic and contextual features) is sufficient, the item is recognized correctly for a studied item (global matching models; e.g., Gillund & Shiffrin, 1984). When a critical theme word is presented at test, this same matching process is initiated and a search for both semantic and contextual features commences. Since critical theme words are semantically related to studied list words, and high-BAS items are more related, a high-BAS studied item may be retrieved. Thus, the critical theme word is falsely recognized and given the source attribution from the mistakenly-retrieved study item.

These studies did not provide direct support for either of these hypotheses. However, our finding that the source-strength effect was large even when source memory for studied items was poor suggests that illusory recollections containing these contextual details are not the result of retrieving source information associated with a studied item, but may instead be the result of processes at encoding.

A misbinding-at-encoding account of illusory recollection emphasizes that critical theme words are activated and encoded while studying DRM lists. This is more likely to happen while encoding high-BAS items (activation/source monitoring theory of false recall; Gallo et al., 2001) and therefore high-BAS source information is misbound to the "memory" of the nonpresented critical theme word. At retrieval, the illusory recollection (in its entirety) is retrieved when the cue is presented at test. This hypothesis is strengthened by the idea that features are imported or content is "borrowed" when two events are similar (e.g., Lyle & Johnson, 2006; Lampinen et al., 2005). While studying the DRM lists, our participants may have been erroneously binding location information of high-BAS words to the theme word.

Future Directions

A motivation for conducting these experiments was to evaluate whether sources that were more easily manipulated along a continuum, and thus less discriminable, would demonstrate a source-strength effect. We are currently conducting research that manipulates the location of studied items relative to the BAS of the studied items to better understand the variables influencing illusory recollection of source information.

In this line of research we have been discussing two theories of semantic false memories that attribute illusory recollection of source information to false encoding or recollection of source information associated with studied items. Semantic false memory is thought to be due to the associations presented in word lists. Words may be mentally related in one's pre-existing mental lexicon, co-occur frequently in language, share the same categorical membership, or be similar in concept (Gallo, 2006). This spreading activation/association view rests on the assumption that part of memory is a network organization in which associations at the word level are linked together so that accessing one word causes an activation to spread to related words and/or concepts (e.g., McDermott & Watson, 2001; Roediger & McDermott, 2000; Nelson, Schreiber, & McEvoy, 1992). In this view illusory recollection is the result of misbinding. A second theory that links the memory for source information to the memory for studied items is the feature overlap view, where experienced events (studied items) are encoded as bundles of features and the overlap between features of the test word and studied items creates a memory signal for true or false recognition (Arndt & Hirschman, 1998). Here, illusory recollections are the result of retrieving the source information associated with a studied item.

Another major theory of semantic false memories that we have not discussed to this point claims that semantic false memories are distinct representations of the thematic consistency of the studied list. In this view, semantic false memories are the result of retrieving a gist representation (Brainerd, Wright, Reyna & Mojardin, 2001). This view has relied on similar mechanisms to the association/monitoring and feature overlap views to account for the illusory recollection of source though. However, the idea that a false memory is the encoding of a summary (gist-based) representation for an event is similar to the idea of a "prototype": the extracting of an abstract representation (prototype) that captures the basic pattern across a list of associated items during learning (Posner & Keele, 1968; 1970). Posner and Keele demonstrated that individuals could come to recognize a pattern of dots presented in different locations as part of a category if the training dot patterns were slight variations of the later tested prototype (1968). In essence, individuals learn to recognize one set of locations as being the gist of the training set.

Our current studies will help determine if location information reported in illusory recollections is due to borrowing location information from highly-associated list items or the creation of a memory trace that includes location information based on a prototypical representation of source. One way to explore this is to utilize more than two locations and divide each DRM list into several BAS-based sub-lists. If a falsely-recognized critical theme word is attributed to a source in which high associates are presented, the false memory may contain borrowed location information from high associates. If it is attributed to a source in which no studied items were presented, but it is a location near to the location in which high associates were presented, then the false memory may contain averaged, or prototypical, source information.

Concluding Remarks

The research reported here demonstrates a source-strength effect is found even with sources that are harder to discriminate. Although we cannot conclude anything about theory from these data, we suggest that the large effect size for the source-strength effect suggests that accurate memory for source information may not be required to observe the effect. Alternately, source information that is contained in an illusory recollection may be the result of accessing a memory representation in which source information is better encoded, for example, if it is the result of processing the similarity across the studied episode (the gist encoding).

The outcome of this research contributes to the general question of how false memories become rich in contextual detail. The premise that source information of highly associated words is more often attributed to falsely-remembered words, and that location information can be utilized to accomplish this effect, leads us towards an exciting and new line of investigation.

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Appendix

The Twelve 15-Word Lists Used in this Experiment

We chose to use the same lists as Hicks and Starns to replicate their source-strength effect using location (2006). We added two additional lists for counterbalancing purposes.

Critical Item	Word	BAS	FAS	Critical Item	Word	BAS	FAS
Bread	rye	.791	.000	King	throne	.759	.000
	loaf	.552	.051		queen	.730	.772
	butter	.364	.487		crown	.471	.016
	toast	.364	.000		reign	.383	.000
	dough	.310	.058		monarch	.317	.039
	crust	.243	.000		royal	.315	.016
	flour	.142	.000		palace	.159	.000
	sandwich	.067	.026		prince	.134	.016
	jam	.054	.000		chess	.092	.000
	jelly	.053	.019		leader	.034	.000
	slice	.048	.019		dictator	.023	.000
	milk	.012	.000		George	.020	.000
	food	.000	.045		rule	.014	.031
	eat	.000	.026		England	.000	.000
	wine	.000	.000		subject	.000	.000
City	metropolis	.536	.000	Mountain	climber	.603	.031
	town	.529	.307		hill	.428	.265
	New York	.383	.066		climb	.291	.092
	urban	.358	.000		molehill	.256	.031
	suburb	.265	.010		peak	.248	.020
	county	.195	.010		valley	.195	.020
	Chicago	.152	.000		summit	.108	.000
	state	.117	.132		steep	.061	.000
	capital	.095	.000		ski	.034	.000
	country	.068	.020		bike	.033	.000
	streets	.054	.046		goat	.028	.000
	village	.020	.000		glacier	.020	.000
	big	.000	.025		range	.000	.051
	crowded	.000	.010		top	.000	.041
	subway	.000	.000		plain	.000	.000
Doctor	physician	.804	.040	Needle	thread	.758	.424
	nurse	.547	.379		syringe	.520	.000
	stethoscope	.520	.000		haystack	.418	.030
	surgeon	.479	.040		injection	.331	.000
	patient	.365	.025		pin	.289	.212
	clinic	.300	.000		thimble	.218	.000
	dentist	.214	.020		sewing	.181	.224
	medicine	.152	.066		knitting	.135	.000
	lawyer	.149	.101		prick	.108	.012
	health	.049	.020		sharp	.030	.024
	sick	.031	.051		thorn	.028	.000
	cure	.028	.010		point	.024	.024
	hospital	.027	.015		cloth	.000	.000
	office	.014	.010		hurt	.000	.000
	ill	.000	.025		eye	.000	.000

Critical Item	Word	BAS	FAS	Critical Item	Word	BAS	FAS
Rough	sandpaper	.429	.041	Sweet	honey	.451	.000
	smooth	.416	.352		bitter	.435	.020
	course	.291	.014		sugar	.433	.061
	tough	.192	.048		sour	.405	.372
	rugged	.174	.014		candy	.336	.162
	jagged	.128	.000		tart	.223	.000
	bumpy	.150	.028		chocolate	.101	.041
	riders	.027	.000		nice	.095	.095
	uneven	.019	.000		taste	.071	.014
	boards	.000	.000		cake	.027	.000
	gravel	.000	.000		tooth	.000	.027
	ground	.000	.000		good	.000	.014
	ready	.000	.000		heart	.000	.000
	road	.000	.000		pie	.000	.000
	sand	.000	.000		soda	.000	.000
Slow	fast	.598	.527	Trash	garbage	.456	.526
	snail	.486	.020		rubbish	.397	.013
	turtle	.372	.115		debris	.266	.000
	sluggish	.340	.000		dump	.218	.013
	quick	.272	.000		litter	.209	.000
	molasses	.170	.000		landfill	.186	.000
	lethargic	.142	.000		junk	.126	.013
	speed	.061	.014		waste	.067	.026
	delay	.059	.000		sewage	.053	.000
	hesitant	.034	.000		pile	.049	.000
	cautious	.027	.000		scraps	.048	.000
	traffic	.020	.000		refuse	.017	.000
	stop	.000	.034		can	.014	.212
	listless	.000	.000		bag	.000	.026
	wait	.000	.000		sweep	.000	.000
Smell	aroma	.678	.000	Window	pane	.833	.179
	scent	.625	.029		sill	.682	.128
	whiff	.577	.000		shutter	.480	.000
	stench	.562	.000		curtain	.189	.038
	reek	.510	.000		door	.156	.147
	sniff	.442	.043		ledge	.152	.013
	perfume	.393	.036		glass	.144	.256
	fragrance	.389	.000		view	.048	.026
	nose	.108	.116		screen	.027	.000
	rose	.034	.000		shade	.021	.058
	salts	.028	.000		open	.014	.019
	breathe	.000	.000		frame	.014	.013
	hear	.000	.000		breeze	.000	.000
	nostril	.000	.000		house	.000	.000
	see	.000	.000		sash	.000	.000

Table 1

Source Accuracy for Studied Items by Encoding Condition for Experiment 1

	"Left"		"Right"	
Condition	High-BAS	Low-BAS	High-BAS	Low-BAS
Incidental encoding	.514 (.042)	.392 (.032)	.597 (.036)	.378 (.040)
Intentional encoding	.516 (.042)	.375 (.032)	.550 (.036)	.427 (.040)

Note. Proportions are shown as means with standard errors in parentheses. Proportions reflect the number of items from a given source with correct source claims (e.g., studied on left and attributed to "left" side) divided by the number of items of a given source with any studied source claim (e.g., studied on left and attributed to "left" or "right" side).

Table 2

Source Attributions for Critical Theme Words by Encoding Condition for Experiment 1

	"Left"		"Right"	
Condition	High-BAS on left	Low-BAS on left	High-BAS on right	Low-BAS on right
Incidental encoding	.419 (.046)	.263 (.034)	.459 (.043)	.245 (.042)
Intentional encoding	.376 (.046)	.202 (.034)	.526 (.043)	.326 (.042)

Note. Proportions are shown as means with standard errors in parentheses. Proportions reflect the number of critical items given a source claim (e.g., "left" or "right") divided by the number of falsely-recognized critical theme words presented at test in which either the high or low associates were presented in a given source at study.

Table 3

Source Accuracy for Studied Items for Experiment 2

	"Left"		"Right"	
	High-BAS	Low-BAS	High-BAS	Low-BAS
Source accuracy	.466 (.029)	.461 (.029)	.540 (.030)	.440 (.030)

Note. Proportions are shown as means with standard errors in parentheses. Proportions reflect the number of items from a given source with correct source claims (e.g., studied on left and attributed to "left" side) divided by the number of items of a given source with any studied source claim (e.g., studied on left and attributed to "left" side, "right" side, or called "do not remember source").

Table 4

Source Attributions for Critical Theme Words for Experiment 2

	"Left"		"Right"		"Do not remember source"	
	High-BAS on left	Low-BAS on left	High-BAS on right	Low-BAS on right	High-BAS on left	High-BAS on right
Source attributions	.403 (.033)	.246 (.035)	.433 (.045)	.268 (.036)	.329 (.044)	.321 (.045)

Note. Proportions are shown as means with standard errors in parentheses. Proportions reflect the number of critical items falsely recognized by response (e.g., "left", "right", or "do not remember source") divided by the number of falsely-recognized critical theme words in which either the high or low associates were presented in a given source.

Table 5

Source-Strength Effect Comparison Table

Research	Source types	False memory	Source-strength effect
Hicks & Hancock (2002) Exp 1, Exp 2	Videotaped male versus videotaped female	.800	.671
Hicks & Starns (2006); Exp 1, Exp 3A(1), Exp 3B(1)*	Text versus auditory	.678	.637
Hicks & Starns (2006); Exp 2	Text versus pictorial	.650	.638
Hicks & Starns (2006); Exp 3A(2), Exp 3B(2)*	Anagram text versus auditory	.695	.671
Browning Thesis (2009); Exp 1, Exp 2*	Left versus right locations	.690	.626

Note. False memory proportions reflect the number of critical items falsely recognized divided by the number of critical items presented at test. Source-strength effects reflect an average of all of the source-strength effects reported for a source type combination (Source types) across a number of studies (Research). For each study, the source-strength effect represents the number of critical items falsely recognized and attributed to the high-BAS source divided by the number of critical items falsely recognized given any source attribution. Experiments that utilized a “do not remember source” option are indicated by an asterisk (*).

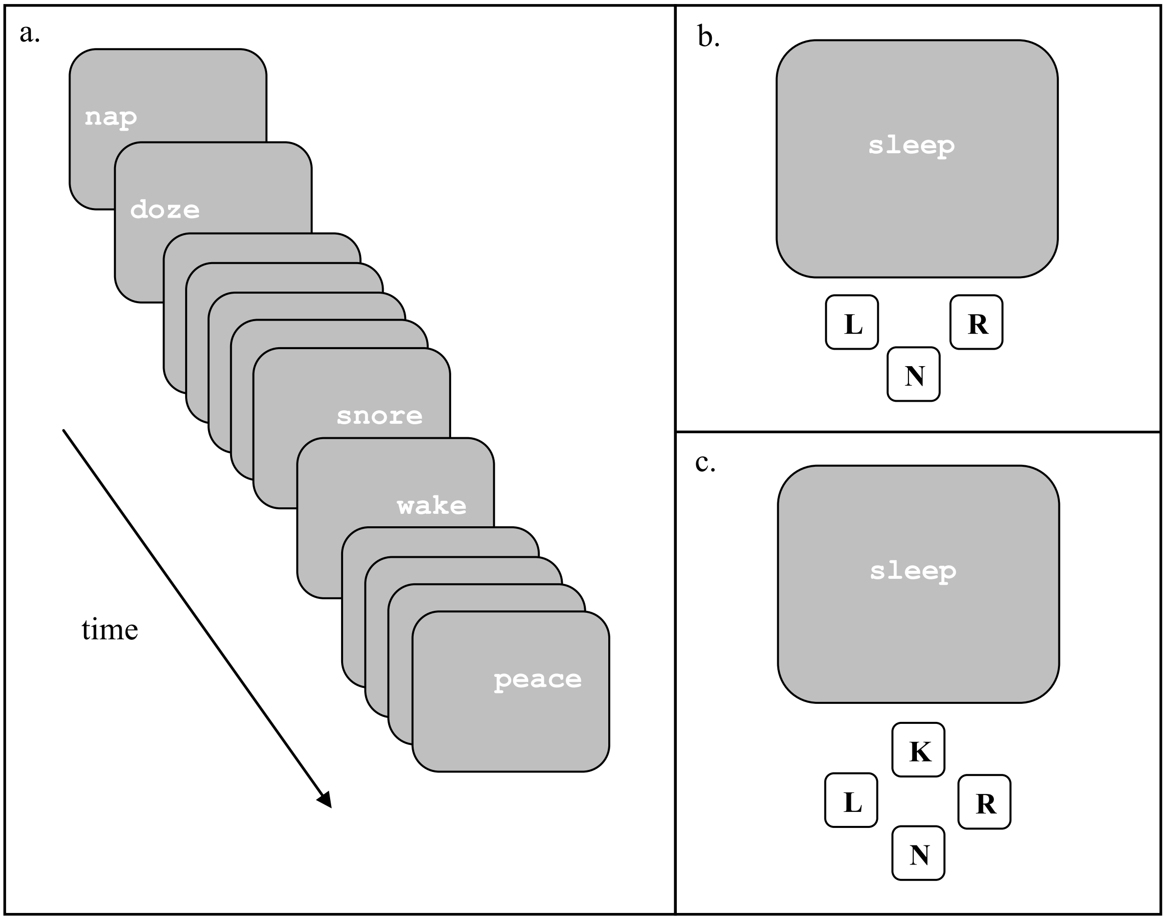

Figure 1. Schematic of the experimental procedure. At study, words from each six-item high- or low-BAS sub-list were presented individually on an assigned side of the computer screen followed by the corresponding DRM sub-list, presented on the opposite side (a); order, BAS, and side of presentation were counterbalanced within and between subjects. At test, old and new items were presented in the middle of the screen in a random fashion. In Experiment 1, participants had three response options: left (*L*), right (*R*), or new (*N*) (b). In Experiment 2, participants had four response options: left (*L*), right (*R*), new (*N*), or "old but do not remember source" (*K*) (c).

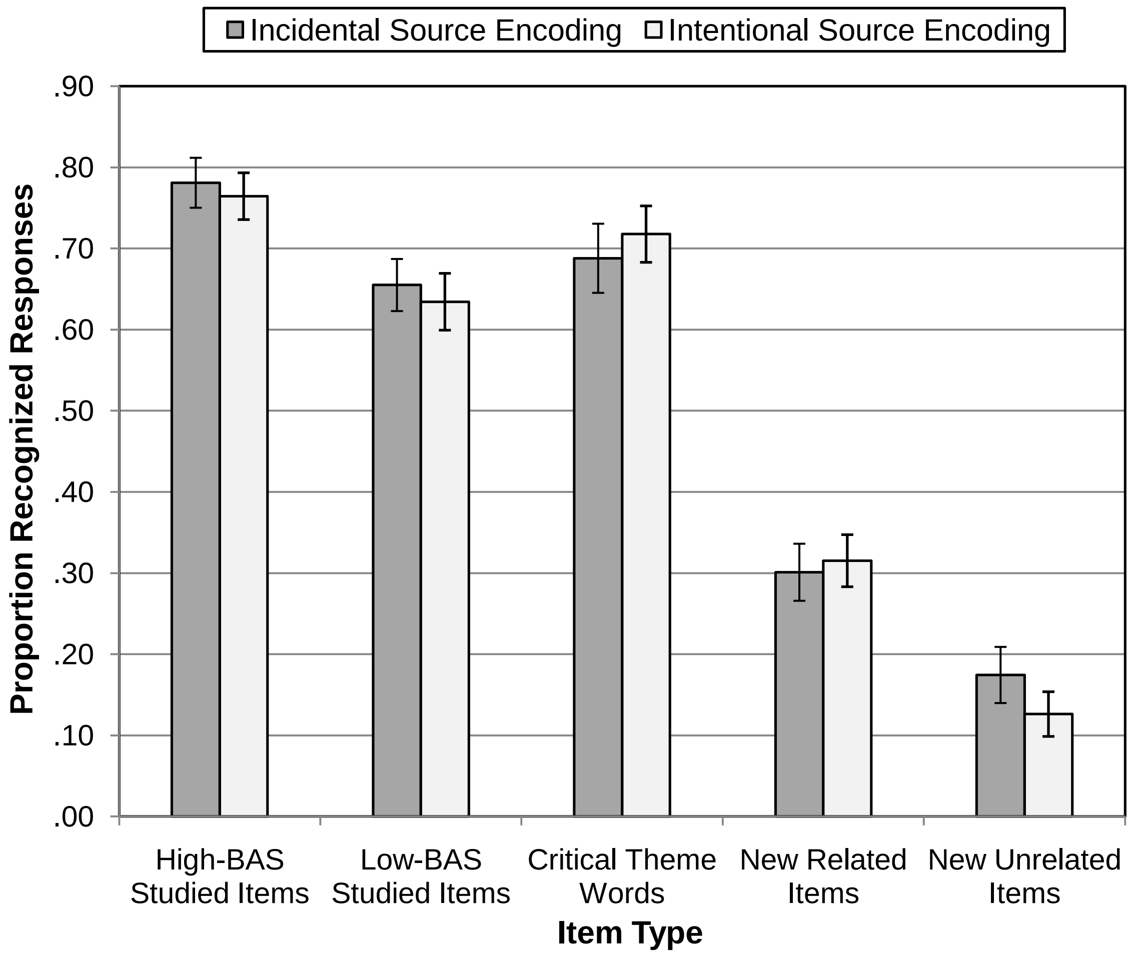

Figure 2. Mean correct and false recognition for each item type in Experiment 1. No encoding condition differences were found in the proportion of recognition responses for each item type. Error bars represent standard errors.

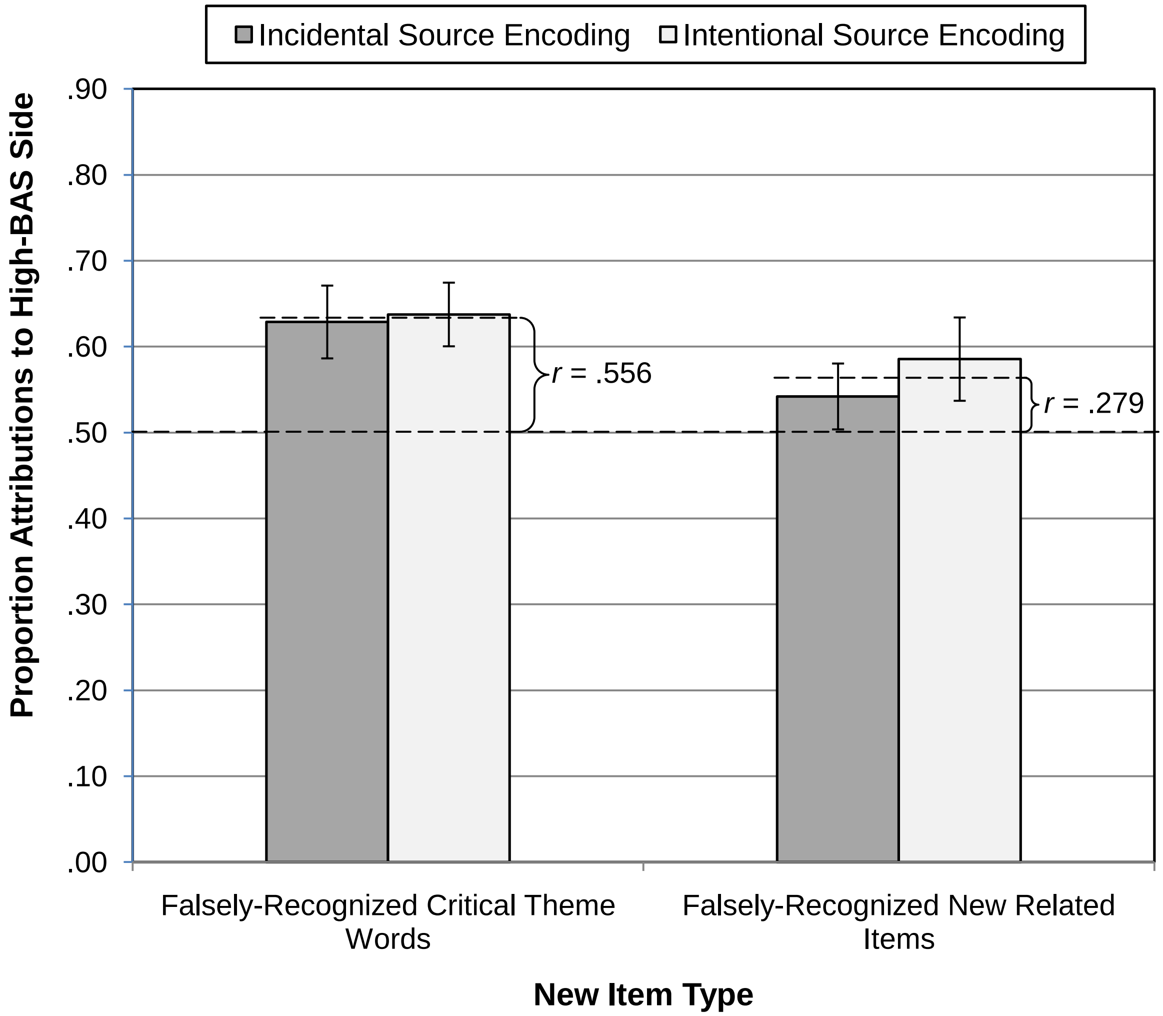

Figure 3. Mean source attributions to high-BAS sides of corresponding lists for critical theme words and new related items in Experiment 1. No encoding condition differences were found in the proportion of attributions for each item type. Dashed lines represent means collapsed across conditions. A source-strength effect was found for both item types, indicated by braces and written as effect size *r* (Cohen, 1992). Error bars represent standard errors.

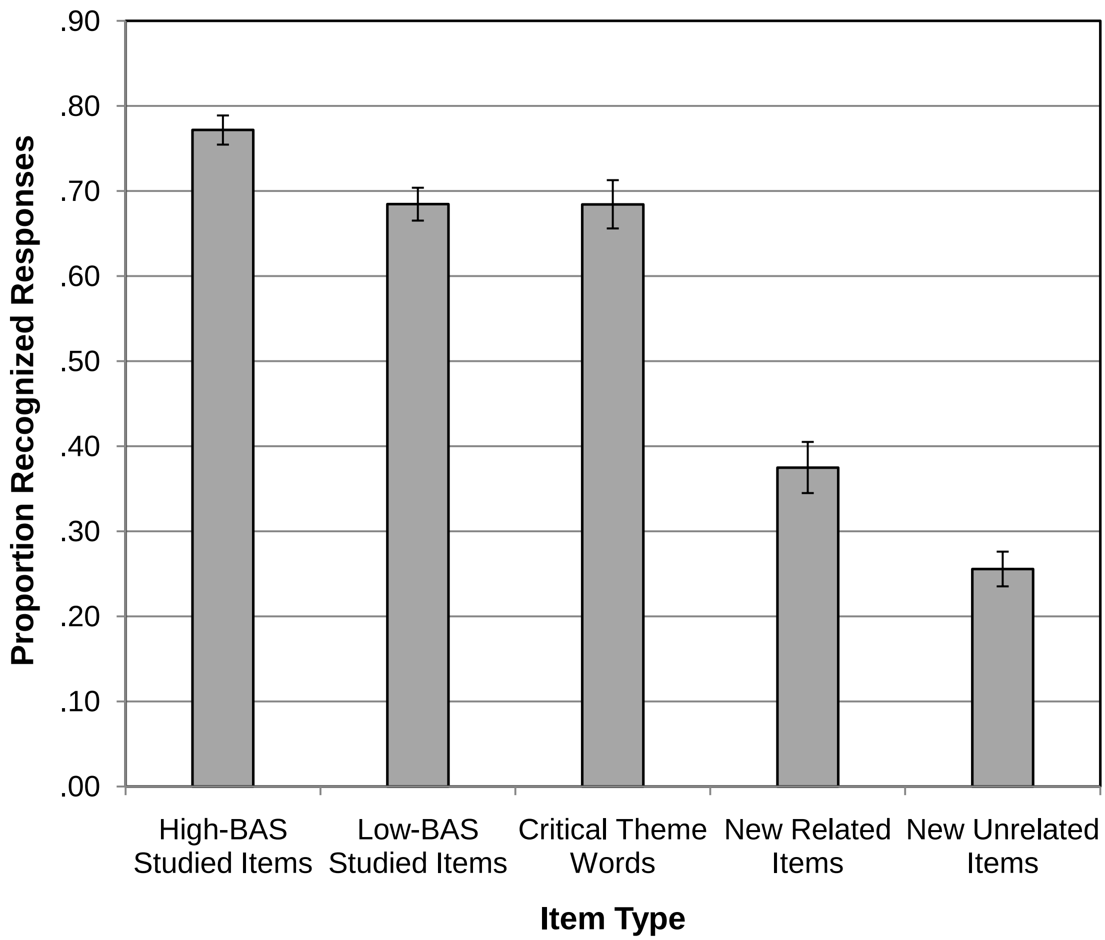

Figure 4. Mean correct and false recognition for each item type in Experiment 2. Error bars represent standard errors.

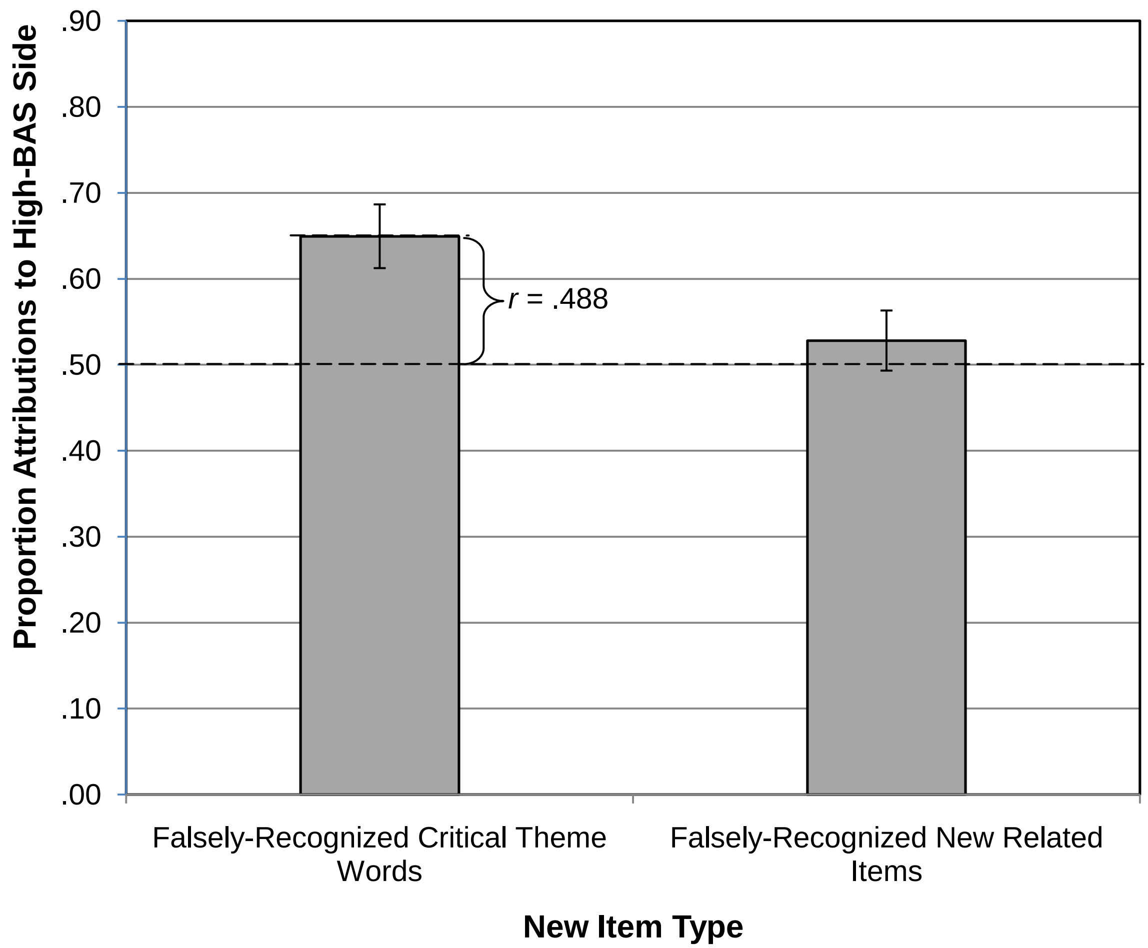

Figure 5. Mean source attributions to high-BAS sides of corresponding lists for critical theme words and new related items in Experiment 2. Proportions are calculated as the number of source attributions to high-BAS side divided by number of source attributions to any side. A source-strength effect was found for critical theme words, indicated by braces and written as effect size *r* (Cohen, 1992). Error bars represent standard errors.