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The effects of internal and external context reinstatement on source memory

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THE EFFECTS OF INTERNAL AND EXTERNAL
CONTEXT REINSTATEMENT ON SOURCE MEMORY

A Thesis

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Master of Arts

in

The Department of Psychology

by
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B.A., Southeastern Louisiana University, 2001
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ABSTRACT

Memory for attended aspects of an encoded event (item memory) is facilitated when features of the encoding context are reinstated at test, indicating that item and context features are bound together in memory traces (Smith, 1979). The present study investigated whether reinstated contextual features similarly enhance memory for other contextual details of an event (source memory). Participants studied words that appeared on either the top or bottom of the computer screen in either a large or small font size. Following the study phase, participants completed a recognition/source test in which they had to indicate the location in which they studied each recognized word. The effects of external context reinstatement on location memory were evaluated by testing words in either the same font size in which they were studied or a mismatching font size. Location memory was not affected by the match of font-size features between encoding and retrieval. The effects of internal reinstatement of contextual details were evaluated by having participants report the contextual details that they recollected for each word that they recognized. Location memory was better when participants internally reinstated font-size information by recollecting this feature than in situations where contextual details were not recollected. Other details recollected from the encoding context were also associated with enhanced memory for location. This study demonstrates different effects of internal and external context reinstatement on source memory. Although recollecting font features was associated with enhanced location memory, font features reinstated as part of the test environment had no effect on location memory. Thus, the results provide only partial evidence that contextual features are bound to other contextual features.

INTRODUCTION

Memory stores an unfathomable body of available information. The information that can be accessed at a given moment, however, is quite limited (Tulving & Pearlstone, 1966). The encoding specificity principle (Tulving & Thompson, 1973) offers a theoretical basis for predicting the accessibility of information in a given test context, and it has proven to be a useful tool in explaining data arising from a wide variety of manipulations in memory research. According to this principle, remembering an event consists of a reawakening of the processes that were active when the event was encoded (Roediger, 2000). Thus, a person can remember that a word appeared on a particular list if that person can access the perceptual and elaborative operations that were performed when the word was encountered in the list (Tulving & Thompson, 1973). Features of the test environment influence memory by either promoting or discouraging the reinstatement of information reflecting encoding processes. Retrieval is facilitated when test conditions match encoding conditions, for instance, when memory for words is tested in the same room in which the words were learned (Smith, 1979). The reinstatement of encoded details can also be achieved as part of the rememberer's *internal* environment; for instance, recall is facilitated when participants are instructed to remember the room in which they learned a list of words (Smith, 1979, 1984). Thus, according to this principle, the most effective retrieval cues are those that replicate encoding processes in some way.

Although many studies have explored the effects of cueing on item memory, very few have investigated the role of retrieval cues on one's ability to remember the source of information (Dodson & Shimamura, 2000; Meiser & Broder, 2002). Source memory is memory for the conditions in which a given item was encoded. In a typical experiment, a

participant may be asked to determine whether an event was previously imagined or perceived, or whether a word was presented in a male or female voice. The Source-Monitoring Framework (Johnson, Hashtroudi, & Lindsay, 1993) provides a comprehensive description of the cognitive processes involved in remembering the source of retrieved information. According to this framework, the source of an item cannot be directly retrieved as an abstract label; rather, source must be inferred by assessing various memory attributes that reflect the processes recruited at encoding. Attributes bound in the memory trace can be perceptual, spatial, temporal, or semantic in nature, as well as information regarding the thoughts and emotions that were experienced when the target information was acquired. Some subset of the encoded attributes are re-activated when the memory is retrieved, and the rememberer sets criteria for the type and amount of information that is diagnostic of a certain source.

The present study was conducted to determine if the cues available at retrieval influence the pattern of memory attributes that becomes active, thus influencing the eventual source decision. Specifically, I am interested in the possibility that information from one source dimension can serve as a cue to information from another dimension; that is, whether or not reinstating some detail of an item's encoding context will increase access to other details bound in the memory trace. At a basic level, the encoding-specificity principle suggests that source memory will be improved when contextual cues are provided. The cues will reinstate encoding conditions, and this should increase access to all encoded information, including incidentally processed contextual details. However, although prior research has established that contextual details are bound to item information (Chalfonte & Johnson, 1996), it is not known whether contextual details

are similarly bound to other contextual details, such that the activation of one will directly influence the activation of another. Empirical efforts are needed to determine the true relationship among memory attributes surrounding a particular event (Meiser & Broder, 2002).

This study will compare external and internal reinstatement of the source dimension used as a cue. The cueing information will be available either because the information is experienced by the rememberer as part of the test context (external reinstatement), or because the rememberer can consciously recollect the information (internal reinstatement). It is possible that source memory will be improved by the availability of both internal and external cues. For example, imagine a situation in which a politician remembers making a statement regarding her opinion on tax relief, and she is trying to remember who she was talking to when she made this declaration. If internally reinstated details can serve as cues to source information, then she should be more successful if she first recollects other details of the event, such as where she was when she made the statement. If external reinstatement has the same effect, she should be more likely to remember who heard the statement if she happens to be in the same room where she made the statement.

Experiments employing the remember/know procedure in conjunction with source memory tests provide data that is potentially relevant to the effect of internal reinstatement on source memory. The remember/know procedure was originally developed by Tulving (1985) to study the experiential correlates of retrieval, and it has subsequently been used by many researchers to discriminate between positive recognition responses based on recollection of the learning event and positive recognition responses

based on familiarity in the absence of recollective details (e.g., Gardiner, 1988; Rajaram, 1993; Yonelinas & Jacoby, 1995). The procedure simply adds one more decision to a standard recognition test. For words that participants claim to recognize, they are asked to say they “remember” the word if they can recollect any specific detail or details of the event of encoding the item. They are to say that they “know” an item if they were able to recognize it although they could not remember any details unique to the encoding event. Many experiments have shown that source monitoring is more accurate for “remember” than for “know” responses. For example, Perfect, Mayes, Downes, & Van Eijk (1996) reported a series of experiments in which they asked participants to make remember/know judgments followed by a test of their memory for source information, such as which of two temporally distinct lists contained a given word (Experiment 2) or in which of four different positions on the computer screen a word appeared when it was studied (Experiments 3 & 4). In all cases, source accuracy was higher for words given “remember” as opposed to “know” responses. Furthermore, in all but one experiment, source accuracy following “know” responses was not discriminable from chance performance. Similarly, Dewhurst & Hitch (1999) found that participants’ accuracy in deciding if words were either generated from an anagram or read intact was markedly higher for “remember” than for “know” responses, and Conway & Dewhurst (1995) showed that the state of recollection is associated with an enhanced ability to distinguish performed from observed or imagined actions. Finally, in two experiments, Donaldson, MacKenzie, & Underhill (1996) demonstrated that the proportion of items that participants claim to recollect is highly similar to the proportion of items that can be attributed to the correct encoding context in a source test.

All of the above studies suggest that source memory is more accurate when recollective attributes are activated at retrieval. This implies the possibility that details of the encoding context reinstated as a result of recollective processes accompanying a recognition decision can serve as cues to the retrieval of source information. However, the results of the studies cited above are ambiguous as to the specific cueing relationship among memory attributes, because there is no way to know what type of information was retrieved as the basis for each “remember” response.

Studies in which participants are asked to report the detail or details that they recollect following “remember” responses show that participants recollect many different types of information when making recognition decisions (Bodner & Lindsay, 2003; Gardiner, Ramponi, & Richardson-Klavehn, 1998; Perfect et al., 1996). In contrast to the wide variety of recollection that can support recognition decisions, source monitoring decisions require the consideration of specific target memory attributes (Johnson et al., 1993). Thus, recollection as defined by a “remember” response can either be criterial or non-criterial to the source task at hand (Yonelinas & Jacoby, 1996). Criterial recollection involves remembering an attribute relevant to the source dimension that forms the basis for the required discrimination (for example, recollecting tone of voice when the source task requires a distinction between male and female sources). Non-criterial recollection involves recollecting an attribute that bears no direct relevance to the current source task (for example, recollecting an association when asked to choose between male and female sources). It is possible that “remember” responses are associated with better source monitoring only when the “remember” responses are based on criterial recollection. That is, “remember” responses are predictive of accurate source memory because people

recollect source specifying attributes during the recognition decision, and later base their source decisions on these attributes. Another possibility is that “remember” responses are predictive of source accuracy even if the details recollected during the recognition decision are non-criterial. Such a relationship could arise because the recollected non-criterial attributes increase access to criterial attributes when a more detailed search of memory is performed for the source decision. Studies asking for simple remember/know distinctions cannot discriminate between these possibilities; thus, their results cannot be taken as direct evidence that memory attributes can serve as cues for other memory attributes.

Meiser & Broder (2002) explored the cueing relationship among memory attributes by systematically varying two source dimensions and directly evaluating the effects of remembering one source dimension on decisions made regarding the other. They presented words in a large or small font at the top or bottom of the computer screen. The two font and location source dimensions were factorially crossed, so that knowing one source of a given word would not by itself give any information regarding the second source dimension. They administered a standard recognition test where each positive recognition response was followed by a remember/know judgment, which was itself followed by location and then font-size judgments. One goal of their work was to address whether retrieving information correctly from one source dimension (location) is associated with more accurate source decisions on another (font).

Results showed that source memory decisions were more accurate when they followed “remember” judgments as opposed to “know” judgments, once again supporting the relation of recollection and source memory reported in other studies.

Additionally, in the state of recollection, memory for font was much better when location was correctly retrieved than when it was not. The authors interpreted this as evidence that the location information retrieved as part of the first source decision cued the retrieval of font information. Thus, their results strongly suggest that font and location memory attributes are stored in a dependent fashion such that activating one attribute promotes the activation of another. They contend that this relationship of mutual cueing will not extend to all memory attributes, and specifically suggest that non-sensory attributes such as a recollected association will not influence the retrieval of sensory attributes such as font and location. Although they did not directly evaluate the influence of non-sensory attributes, some features of their results suggest that recollection of non-sensory details may be independent of font recollection. For instance, when location information could not be recollected, the probability of recollecting font information was only around 25% for both “remember” and “know” responses. This suggests that, for font decisions, recollecting details other than location provided no advantage over a mere feeling of familiarity.

To directly evaluate the effect of both sensory and non-sensory recollection on source judgements, I explored the effects of internal reinstatement by supplementing remember/know decisions with more detailed reports of the specific attributes that were recollected as the basis of the recognition decision. As in Meiser & Broder (2002), participants studied words that appeared either in a large or a small font and either on the top or bottom of the computer screen, with all four combinations of font and location appearing equally often. For the memory test, participants were asked to discriminate studied from non-studied words and to indicate whether their recognition decision was

based on recollected details, a feeling of familiarity, or merely a guess. Following this decision, participants chose the type (or types) of information that they recollected (if any) from a number of categories reflecting the types of information that are typically recollected in word recognition (Bodner & Lindsay, 2003; Gardiner, Ramponi, & Richardson-Klavehn, 1998). Just as Meiser & Broder found that information retrieved as part of one source decision can serve as a cue to other attributes on subsequent memory decisions, the goal of this study was to seek evidence that information recollected as part of a recognition decision can subsequently serve as a cue to source information.

One advantage of the subjective report procedure used in this study is that source performance following several distinct types of recollection can be evaluated. The difference in source memory performance following criterial and non-criterial recollection is one broad distinction of interest. As mentioned above, in studies showing enhanced source memory in the state of recollection, it is not clear whether the advantage results only from recognition based on criterial recollection. If non-criterial recollection is also found to be associated with enhanced source memory, this would suggest a cueing relationship among memory attributes. This study will also compare performance for non-criterial recollection based on the retrieval of font attributes and non-criterial recollection based on other, non-sensory attributes (such as associations). As Meiser & Broder (2002) suggest, it is possible that two sensory attributes such as font and location are stored in a more dependent fashion than sensory and non-sensory attributes. If this is the case, then there should be a stronger association between font recollection and correct location memory than between non-sensory recollection and correct location memory.

A central goal of this study was to compare contextual details reinstated as part of the test environment and details mentally reinstated by the rememberer. Toward this end, targets on the recognition test appeared either in the same font size in which they were studied (the match condition), in a mismatching font size that was seen for other items (the familiar mismatch condition), or in an intermediate font size that was never seen in the study phase (the novel mismatch condition). Just as font information may increase access to location attributes when recollected by the rememberer, location judgments may be facilitated when the correct font size is externally reinstated relative to situations in which font size does not match between study and test.

The cueing procedure that was used in this study is similar to manipulations used in a series of studies on context-dependent recognition undertaken by Murnane and Phelps (1993, 1994, 1995). In these studies, participants learned words in a number of contexts defined by different configurations of location on the screen, font color, and background color. They then completed a recognition test for items that appeared in either a studied context or a novel context. The results consistently showed more recognition responses for words appearing in studied contexts than in novel contexts. The authors demonstrate that their results are successfully accommodated by global-activation memory theories, such as their generalized context model, or, more recently, the ICE model (Murnane, Phelps, & Malmberg, 1999). Global-activation theories assume that memory performance depends on the match of information in retrieval cues and a set of items in memory. Retrieval cues can match both intentionally and incidentally encoded information, and each matching feature increases the summed global activation score for the set of items in memory. This global activation value

determines recognition decisions, with positive responses occurring when total activation is high enough to pass a response criterion.

Although global-activation theories clearly (and correctly) propose that contextual cues influence item memory, this prediction may not extend to memory for source details in a straightforward fashion. For example, according to the ICE theory, reinstating incidentally encoded context information increases activation by matching information stored in numerous memory representations. The benefit in activation is not unique to any single event; in fact, recognition results consistently show that context cues promote positive recognition responses for words that never appeared in any of the studied contexts to a similar extent as words that were directly associated with the reinstated context (Murnane & Phelps, 1993, 1994, 1995). It is not clear that such diffuse activation will improve source memory, in which the specific, rather than the generalized, context associated with a single item must be retrieved. Furthermore, the effect of contextual cues in word recognition is associated with increased familiarity as opposed to recollection (Gregg & Gardiner, 1994). As noted above, familiarity does not typically support accurate source responding (Perfect et al., 1996; for an exception see Hicks, Marsh, & Ritschel, 2002). Thus, it is possible that contextual cueing manipulations will not affect source memory. Also in support of this assertion, Kirsner (1973) found that re-presenting items in the same versus a different font case in a continuous-recognition paradigm affected recognition performance but had no apparent influence on the ability to remember the original font-case of the word, and Craik & Kirsner (1974) replicated these results using voice as the reinstated detail.

Other studies do suggest that context reinstatement affects source memory (Dodson & Shimamura, 2000; Palmeri, Goldinger, & Pisoni, 1993). Dodson & Shimamura presented words in either a male or female voice, then tested the words in either the same voice in which they were studied or the other studied voice. They compared voice memory performance in these two conditions to either visual-only tests or tests in which words were presented in a voice that was not heard in the study phase. They found that source memory was more accurate when words were tested in the same voice in which they were studied compared to visual only tests and novel test voices. Additionally, source performance suffered when test words were presented in the wrong studied voice compared to the other conditions. To account for these results, the researchers concluded that the familiar test voices served as cues for source memories. This cueing facilitated performance when words were presented in the same voice. However, presenting test words in the wrong studied voice cued inappropriate source memories, and this information interfered with the retrieval of source attributes for a given word.

Dodson & Shimamura (2000) demonstrated that source memory is facilitated when study and test environments match in terms of the information that forms the basis of the source decision (e.g., voice cues for a voice judgment). The present study will seek to extend this cueing effect by determining if reinstating one condition of a studied event (font) will improve memory for another (location). If the two memory attributes are stored in a highly dependent fashion, it is possible that cueing with font will increase access to location attributes in comparison to conditions in which items are tested in a

font size not encountered in the study phase. Additionally, presenting items in the wrong studied font may disrupt location decisions by activating interfering source memories.

In summary, participants in this study will learn words that independently vary in terms of font size and location, then they will receive a recognition/source test in which studied words will appear either in their original font size, in the wrong studied font size, or in a novel font size that was not seen in the study phase. During the test, they will 1) indicate the words that they recognize through recollection, familiarity, or a guessing process, 2) report the types of specific details they remembered for words they recollected, and 3) make a location decision. The purpose of the study centers on the ability of font information to cue the retrieval of location attributes. If there is a cueing relationship between these two memory attributes, then location memory should be more accurate for words that trigger font recollection during recognition, as well as for words that are tested in their original font size (which should activate font attributes). Another issue of interest is the extent to which external reinstatement of font in the test environment yields results similar to the internal reinstatement of font through recollective processes. Finally, this study will also determine if the relationship between the recollection of non-sensory attributes (such as associations or temporal information) and location memory is similar to the relationship between font recollection and location memory.

METHOD

Participants

Eighty-two Louisiana State University undergraduates participated in this study. They were tested individually, and received class extra credit for their participation.

Materials

I selected 72 words from Toggia and Battig (1978) to use as the 48 studied words and the 24 lures on the recognition test. The target and lure words did not differ in terms of concreteness ratings (Target $M = 4.70$, Lure $M = 4.79$, $t(70) = .70$, *ns*), imaginability ratings (Target $M = 4.91$, Lure $M = 4.87$, $t(70) = .39$, *ns*), or familiarity ratings (Target $M = 6.05$, Lure $M = 6.15$, $t(70) = 1.06$, *ns*). The studied words appeared in either a 10-point or 48-point font, on either the top or bottom half of the computer screen (the two locations were approximately 8 inches apart). I divided the 48 studied words into four sets of 12, and each set was assigned to one of the four presentation conditions created by the factorial combination of location and font size. The set used for each presentation condition was counterbalanced across participants. The participants studied words for 6 s each in a single random order, with the constraint that there were always at least two intervening items before the same presentation condition was repeated.

The recognition test consisted of the 48 studied words and 24 new words. I divided the 12-words sets assigned to each presentation condition into three subsets of four words. On the test, one subset appeared in an intermediate font size that was not seen in the study phase (26 point), one subset appeared in the large font size, and the other subset appeared in the small font size. The subsets assigned to each font size were completely counterbalanced across participants, which, in conjunction with the study-

phase counterbalancing, assured that each target word in the experiment appeared in all of the different study and test font sizes an equal number of times. To achieve an equal ratio of lures to targets in each of the test fonts, eight of the distracters appeared in the intermediate font size, eight appeared in the large font size, and eight appeared in the small font size. The test words appeared in a single random order, with the constraints that the lures were distributed evenly throughout the test and that no more than two consecutive test words appeared in the same size.

I created a list of seven categories of recollected information for participants to choose from during the test. To select appropriate categories, I conducted a pilot study including 12 participants. The pilot study matched the current study in all details, except that following each "recollect" response, participants free-reported all of the specific details that they remembered about seeing the word in the study phase. All responses were tape recorded, and almost all of the details reported fell into one of the following categories: associations, other thoughts (besides associations), font size, order, location, and mental images. I used these categories for the list that participants selected from in this experiment, and I also included an "other" category for occasions when participants recollected a detail that did not fall into one of the given classifications.

Procedure

At the beginning of the experiment, the experimenter told the participants that they would be presented with words that they should remember for a later, unspecified memory test. The study list was presented, then the experimenter instructed participants to complete multiplication problems for five minutes. After this period, the experimenter collected the multiplication sheet and administered the test instructions.

The test instructions informed participants of the sequence of memory decisions that they would make on the test. (The verbatim test instructions used for this experiment can be seen in the Appendix.) For each test word, participants first decided whether they recollected the word, that the word was familiar, or that the word was new (i.e., was not seen in the study phase). The experimenter described all of these response options in detail. In addition, a “guess” option was included to ensure that participants did not simply use the “familiar” response for low confidence decisions, and participants were told to select this category when they thought that a word was studied but they felt like they were just guessing. Participants made their decisions by pressing stickers marked “R,” “F,” “G,” and “N” which were placed on the “s,” “f,” “h,” and “k” keys, respectively.

For all test words that participants claimed to recognize (i.e., all claims other than “new”), they selected from seven categories of information representing details that they may have recollected when deciding that the word was studied. The categories included “associations,” “thoughts,” “font size,” “order,” “location,” “mental images,” and “other.” Each type of recollection was described to participants in detail, as can be seen in Appendix 1. The categories of information were numbered, and participants typed the number of each type of information they recollected during their recognition decision. Participants were instructed to enter nothing when they did not recollect specific details when deciding that a word was studied. Once this decision was made, participants were prompted to indicate whether the word appeared on the top or bottom of the screen in the study phase. For this response, a “T” sticker was placed on the “c” key and a “B” sticker

was placed on the “n” key. After the participants finished all of the test words, the experimenter debriefed them and thanked them for their participation.

RESULTS

Recognition Performance

Table 1 displays the average proportion of positive responses made to targets and lures in each memory state. Participants frequently made “recollect” responses to targets (.39), but rarely falsely claimed to recollect a lure (.03). More familiar responses were made for old (.24) than new (.10) items, but the familiarity false alarm rate was noticeably higher than false alarms associated with the state of recollection. Finally, when guessing that an item was old, participants showed no ability to distinguish between targets and lures, with responses to lures (.23) actually exceeding responses to targets (.18).

TABLE 1: Proportion of old and new items assigned to each memory state. The values in parentheses are standard errors.

Item Status	Memory State		
	Recollection	Familiarity	Guessing
Old	.39 (.02)	.24 (.01)	.18 (.01)
New	.03 (.01)	.10 (.01)	.23 (.02)

I performed analyses comparing the various font cueing conditions in terms of hit and false alarm rates, with the dependent variable being all “old” responses (i.e., any response other than “new”). The relevant data are displayed in Table 2. The test cues significantly affected “old” responses to targets, $F(2,162) = 8.68, p < .001$. Bonferroni-adjusted pairwise comparisons revealed that there were more hits in the match (.84) condition than either the novel (.78) or familiar (.80) mismatch conditions, and the latter two did not differ. Although the false alarm rate for lures presented in a studied font size (.36) was higher than that of lures presented in a novel font size (.33), this difference did

not reach significance, $t(81) = 1.52, p = .13$. Because false alarm rates for studied and novel font sizes were nominally different, I computed corrected recognition scores by subtracting the studied-font false alarm rate from the hit rate in the match condition and the novel-font false alarm rate from the hit rate in the novel mismatch condition. (I did not include the familiar mismatch condition in the corrected recognition analyses, because this condition shared a false alarm rate with the match condition). Corrected recognition for the match (.48) and novel mismatch (.45) conditions did not differ, $t(81) = 1.05$, suggesting that general claims of "old" increased in the presence of familiar font cues.

TABLE 2: Proportion of items recognized across the font-match conditions. The “HR – FAR” column displays the corrected recognition scores. The false alarm rate to lures appearing in the novel font size is shown in the “Novel Mismatch” row, and the false alarm rate to lures presented in a familiar font size (large or small) appears in both the “Match” and the “Familiar Mismatch” rows.

Condition	Hit Rate	False Alarm Rate	HR - FAR
Match	.84 (.01)	.36 (.03)	.48 (.02)
Novel Mismatch	.78 (.02)	.33 (.03)	.45 (.02)
Familiar Mismatch	.80 (.02)	.36 (.03)	.44 (.02)

The effect of font reinstatement on “recollect” responses mirrored the overall recognition data. The test cues significantly affected reported rates of recollection for old items, $F(2,162) = 6.31, p < .005$, reflecting more responses in the match (.43) than either the novel mismatch (.36) or familiar mismatch (.39) conditions, although the latter two did not differ. The recollect false alarm rate was very slightly higher when lures were

presented in a studied font size (.03) than a novel font size (.02), and this difference approached significance, $t(81) = 1.85, p = .07$.

Source Memory Performance

Notes on the Analyses. Source monitoring performance was measured in terms of ACSIM scores, which were computed as the proportion of correctly recognized items that were also attributed to the correct location. Because there are two potential locations, ACSIM scores of .5 represent chance performance, and a score of 1 is indicative of perfect source accuracy. I chose this measure because it is not affected by changes in recognition performance across conditions, and it is also insensitive to a general bias to claim one source versus another (Murnane & Bayen, 1996). The main analyses of interest focused on how these scores differed by cueing condition and by the memory state accompanying the recognition decision. Since all comparisons were within subjects, only participants who had observations in each cell could be included in a given analysis; for instance, in the analysis comparing source performance following recollect, familiar, and guess responses, a participant who never claimed to guess any of the words could not contribute data. For each analysis affected by such dropout, I have noted the number of participants that contributed data, and the corresponding tables will display data for only these participants. The dropout did not significantly affect ACSIM scores in any of the main analyses. I compared the reduced cell means in all of the analyses to the cell means reflecting all participants who contributed data to each cell, and the difference was .02 or smaller in all cases.

I chose to evaluate the effects of memory state and cueing condition in separate analyses, instead of including both of these factors in a single factorial analysis. I did this

because the factorial analysis could only include participants who used all of the memory state responses in each of the cueing conditions, and almost half of the participants in the data set (35) failed to meet this criterion. In contrast, no participants had to be excluded from the cueing condition analysis, and only three participants had to be excluded from the memory state analysis. Furthermore, the 47 participants who could be included in the memory state and cueing condition factorial analysis showed no interaction between these factors, $F(4, 188) < 1$, indicating that no important information is lost by evaluating these variables separately.

External Cues. Font reinstatement had no discernable effect on location decisions, as source scores in the match (.59), novel mismatch (.60), and familiar mismatch (.59) conditions were all similar, $F(2,162) < 1$.

Memory State. I performed a oneway repeated-measures ANOVA to evaluate memory for location following “recollect,” “familiar,” and “guess” responses, and three participants were not included in this analysis because they did not make any “familiar” or “guess” responses. The ANOVA showed significant differences among these categories, $F(2,156) = 18.44, p < .001$, and post hoc analyses showed that source performance following recollection (.67) was higher than either familiarity (.54) or guessing (.51). Source memory following familiar responses was not significantly different from source memory following a guess on the recognition decision. I also compared source memory performance following the recollection of several different types of details. Criterial recollection was defined as any instance in which participants selected the “location” category after making a “recollect” response, font recollection was scored when participants selected the “font” category *without* also selecting “location,”

and non-sensory recollection was scored when participants selected any of the other categories *without* also selecting either font or location. I performed contrasts focused on three key comparisons: whether criterial recollection led to better source performance than non-criterial (font and non-sensory) recollection, whether non-criterial recollection was associated with more accurate source memory than a mere feeling of familiarity, and whether recollection of a sensory non-criterial attribute (font) improved source memory compared to recollection of non-sensory attributes. Figure 1 displays the relevant data. Criterial recollection was associated with better source memory than non-criterial recollection, $t(58) = 4.84, p < .001$. However, non-criterial recollection led to better source performance than a mere feeling of familiarity, $t(75) = 3.62, p < .001$. Although font recollection was followed by nominally higher source accuracy than non-sensory recollection, this difference was not significant, $t(59) = 1.52, ns$.¹

¹ The comparison of source accuracy following the two types of non-criterial recollection may have been affected by the choice to count font recollection before non-sensory recollection (i.e., responses in which both font details and non-sensory details were selected were classified as font recollection). To evaluate this possibility, I ran another analysis in which non-sensory recollection was counted before font recollection, and the results once again showed a non-significant difference between font recollection (.70) and non-sensory recollection (.65), $t(61) = 1.19, ns$.

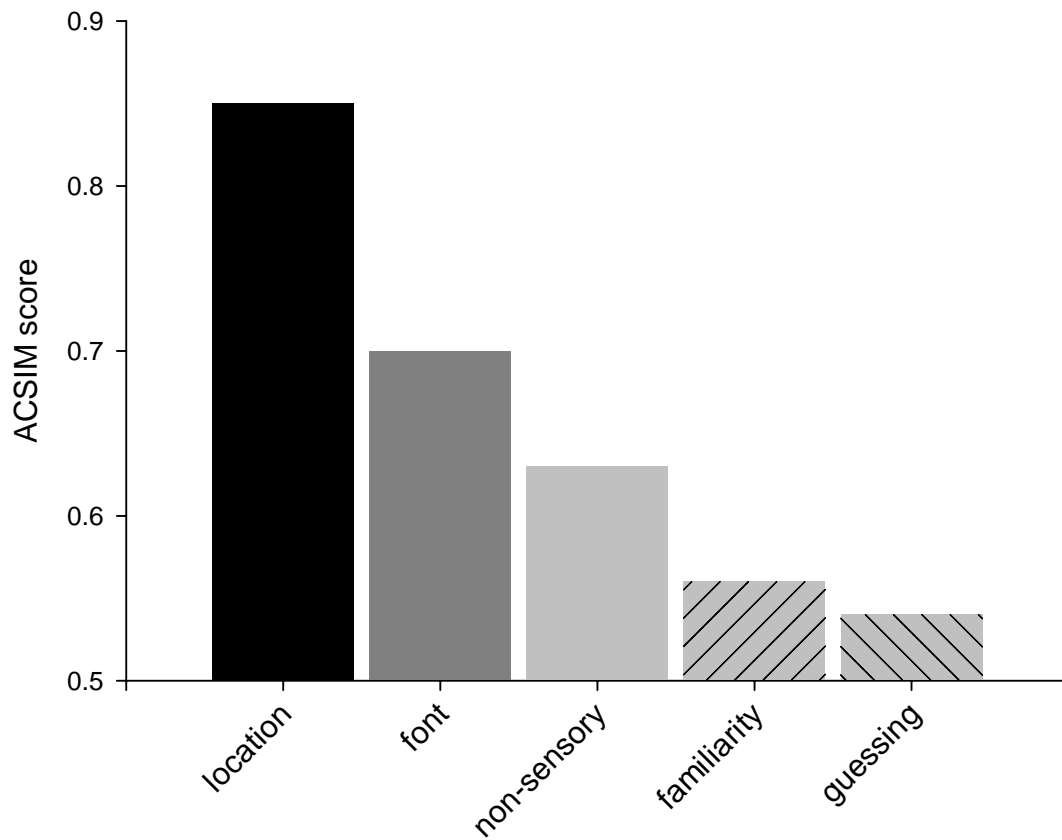


FIGURE 1. Source accuracy for the different memory states and for the specific types of recollected information.

DISCUSSION

The primary goal of this study was to explore the effects of context reinstatement on source memory, and to compare external cues experienced as part of the test environment to internal cues recollected by the rememberer. Internally and externally available context information led to different results, so I will first discuss each type of reinstatement separately, and then consider some potential differences between the two types of information that may help explain their divergent effects.

Externally Available Context Information

In terms of the font cues provided in this study, source memory for location appears to be context independent. The font-cueing condition led to no differences in location memory accuracy, even though the recognition data showed that these cues were effective in altering item memory performance. Dodson & Shimamura (2000) showed that reinstating voice significantly improved voice memory, but the results of the present experiment suggest that such context-dependency in source memory may be limited to situations in which the contextual information that is provided in the cue is the same information needed for the source decision (i.e., criterial information).

The lack of an effect on font reinstatement for location memory suggests that these features are stored independently in the memory trace, because activating font attributes did not promote the retrieval of location attributes. In this way, the external cueing results parallel other paradigms demonstrating independence among memory attributes. For example, Stefurak & Boynton (1986) report experiments where participants saw arrays of ten colored animal shapes, then, after a brief delay, they were shown a single colored shape and were either asked to indicate whether the color had

appeared in the array (regardless of shape) or whether the shape had appeared in the array (regardless of color). They found no advantage in memory when redundant feature information was provided; for example, participants were no more likely to recognize a studied color when the test probe matched a studied item in terms of two features (color and shape) compared to situations in which the studied color was presented as part of a novel shape at test. Thus, providing shape or color information in the test probe did not affect memory for the other feature. Hanna & Remington (1996) report similar results using arrays of colored quadrilaterals as stimuli. In their Experiment 2, participants studied 12 arrays of 6 colored shapes, then took a recognition test in which they had to distinguish studied from non-studied arrays only on the basis of the shapes within the arrays. In separate conditions, the test arrays appeared either in black and white, in color with each shape in the array appearing in its original color, or in color with the original colors reassigned to different shapes within the array. They reasoned that, if color information was stored in association with specific shapes in memory, then people should be better able to recognize arrays when all shapes were their studied colors than when colors were reassigned to shapes. In contrast, if color information was stored independently of shape information, then presenting arrays in their original colors should be beneficial regardless of whether the color-to-shape mapping is preserved from study to test. They found no difference in recognition between consistent color and reassigned color test probes, which led them to conclude that color and shape are represented independently in memory. Finally, Light & Berger (1976) showed that instructing people to remember the font case of words improved memory for this feature without affecting memory for the color of the words, and instructions to remember color similarly had no

effect on memory for font case. Thus, they argue that these contextual features were accessed independently. Marsh, Hicks, & Cook (in press) replicated the selective benefit of intentionally processing a certain source dimension using the learning format (binder or computer screen) and color (black-and-white or full color) of pictures as source features.

Although this experiment revealed no evidence that source memory is sensitive to reinstated contextual details that are orthogonal to the source decision, it is possible that such a relationship may be found in other situations. For instance, many combinations of cueing features and tested source attributes are possible, and there is no a priori reason to expect that all combinations will behave similarly. According to the Source Monitoring Framework, memory attributes can be of various types, including perceptual, spatial, affective, and cognitive-operation information. Although the font and location attributes used in this experiment were thought by Meiser & Broder (2002) to be highly bound to each other because they are both sensory features, they actually belong to different categories of memory attributes (perceptual and spatial) as defined by the Source Monitoring Framework. It is possible that two contextual details from the same category will be more likely to show a cueing relationship than details from different categories.

In addition to other constellations of memory attributes, it is possible that cueing procedures other than the one employed in this study may be more effective for altering source memory performance. This experiment included both match and novel mismatch conditions, so half of the items that were tested in a studied font size actually provided misleading contextual information. This may have made it more difficult for participants to use the font information provided in the test cues. If so, cues may be more effective

when only match and novel mismatch conditions are included on the test, and participants can be sure that any test word presented in a studied context is in the correct context. Cue-to-target mapping may also be an important factor in the effectiveness of context cues. In the present study, a given context (e.g., the large font size) was associated with half of the test words, which may have created cue overload (Watkins & Watkins, 1975). Contexts that are associated with a smaller proportion of studied words may provide more powerful cues.

Internally Available Context Information

Although the external cueing data appear to support the independence of font and location attributes in memory, source memory performance following the recollection of contextual details reveals dependencies among these features. Source accuracy was higher when recognition decisions involved the recollection of specific details than for recognition based on familiarity or a guessing process. Furthermore, the advantage in location memory associated with recollection was not limited to instances in which location information formed the basis of recognition decisions. Non-criterial recollection was also associated with better source memory than familiarity, which suggests that the contextual details reinstated during the recognition decision facilitated the retrieval of source information when participants engaged in a more specific search of memory as part of the source decision. These results are consistent with the dependencies among memory attributes reported by Meiser & Broder (2002). However, although Meiser & Broder suggested that two sensory attributes such as font and location should be more closely bound than sensory and non-sensory attributes, this claim was not strongly supported by this study's data. Although non-criterial recollection of font attributes

appeared to be associated with more accurate location memory than non-criterial recollection of non-sensory attributes, this difference did not reach conventional significance.

Differences in the Two Types of Cues

The present data, along with those of Meiser & Broder (2002), show that internal access to contextual information is predictive of accurate source memory decisions. Meiser & Broder interpreted this relationship in terms of storage/retrieval processes; that is, they concluded that memory attributes are stored in a dependent fashion in memory, so the activation of one attribute cues access to others. However, the present study shows that presenting one type of information as a cue in the test environment had no influence on memory for the other attribute. Thus, the recollection data and the font cueing data appear to be inconsistent: people had better location memory in situations in which they could remember font information than in situations where they did not have access to such details (familiarity), but there was no advantage in location memory when font information was made directly available in the test cue over situations in which it was not. One potential reason for this discrepancy is that internal and external font cues actually provide different types of information to the rememberer. Murnane, Phelps, & Malmberg (1999) have proposed a theory of cueing effects that assumes that there are three general types of information that can match between encoding and retrieval: Item information, Context information, and Ensemble information (thus, it is called the ICE theory). Item information refers to features that received focal processing at encoding (e.g., the conceptual features of the studied words). Context information refers to incidentally processed features that are bound in a memory trace although they are not

central to the memory task at hand; this type of information is also known as *associated* context. Ensemble information refers to contextual features that are meaningfully integrated with the item information. According to the ICE model, when associated context information is provided in a test cue, the relevant contextual feature is activated across an entire set of items in memory. However, providing integrated context information at retrieval activates contextual features that are uniquely associated with a single item in memory.

It seems that the latter type of cue would be more helpful for source memory tasks, where attributes tied to a single event must be accessed. In this experiment, the font cues provided at test are analogous to associated contextual details, so the match between study and test may have activated context information across a set of items in memory. The set of studied items associated with a given font context encompassed items seen both on the top and the bottom of the computer screen, so increasing general activation across the set does not provide useful information to the location judgment. However, when a participant internally reinstates font details for a particular test word, font attributes associated with that item memory become available, which is more analogous to ensemble information. Cues containing associated context versus ensemble information have been shown to lead to different effects in recognition memory, with only ensemble cues leading to greater discriminability. It is possible that differences in these two types of information also underlie the difference between internal and external cues observed in this experiment.

Another possible explanation for the discrepancy between the recollection data and the font-cueing data is that the observed relationship between font recollection and

accurate source memory reflects something other than cueing. A simple possibility is that the dependency between non-criterial recollection and location recollection is driven by an underlying dimension of memory strength: items that are more well established in memory support recollection of all types of contextual details, and, because of this, the same items for which people are likely to report non-criterial recollective details are the items for which location information is likely to be available. This claim is supported by studies showing that manipulations that lead to “stronger,” more memorable item memories also enhance memory for contextual details. For example, modality memory is better following semantic versus structural levels-of-processing tasks (Hayman & Rickards, 1995), and memory for the room in which an item was learned is better for generated than for read items (Marsh, Edelman, & Bower, 2001). An explanation of this sort is also suggested by models that account for the experiential states of recollection and familiarity in terms of a single dimension of memory strength (Donaldson, 1996; Hirshman & Master, 1997).

The simple notion that people’s memory for the studied words includes “strong” items that are likely to support memory for all types of contextual attributes and “weak” items that have a low probability of supporting memory for contextual attributes provides an acceptable account of the observed dependencies among various recollective details and location memory. For example, evaluating the effect of non-criterial recollection on location memory involves 1) separating items into those recognized on the basis of non-criterial recollection and those recognized on the basis of familiarity, and 2) comparing location memory performance for these two classes of items. “Strong” items should be over-represented in the first class, since membership in this class is based on the

recollection of contextual features. Thus, location memory should be greater for the first class of items than for the second. In this way, a relationship between the two attributes could arise independently of any cueing relationship between them.

Item Memory Cueing

Font reinstatement significantly affected recognition memory in this study, and the font-cueing data are consistent with global matching models of recognition performance. According to these models, recognition decisions are determined by the extent to which features activated by a test probe overlap with features stored in memory for a set of items. Thus, presenting items in a studied context adds context features to this overall match, and this promotes positive responding for both studied and non-studied words. According to global matching models, context cues should increase both hit rates and false alarm rates, usually leading to no advantage in corrected recognition (e.g., Murnane & Phelps, 1993). In the present experiment, a matching font size between study and test led to higher hit rates than conditions in which words were tested in a novel font size or a mismatched font size. Furthermore, presenting lure words in a studied font nominally increased false alarm rates, although this difference was not significant. As a result of these false alarm rate differences, the advantage in hit rate for matching over novel font sizes was removed when corrected recognition scores were evaluated.

Conclusions and Future Directions

This study yielded no evidence that contextual details reinstated as part of the test environment increase access to other source attributes, although the same cues were shown to influence item memory. Test context influenced access to central

representations defining intentionally encoded item information; however, once these central features were accessed, memory searches for more specific source attributes associated with item information proceeded independently of test context. Future research is needed to explore the possibility that different types of context cues may be more effective in source tasks, and to further explore the differences in how context cues influence item and source retrieval. As stated above, it may be that integrated context information is more effective than associated context information for cueing source memories. Murnane, Phelps, and Malmberg (1999) encouraged the creation of integrated context information by using contexts that were meaningful scenes that could easily be related to conceptual features of the studied words. Future research efforts can determine if reinstating meaningful contextual features such as the scenes used by Murnane et al. influences access to source attributes.

Dodson & Shimamura (2000) showed that contextual cues enhance source memory when the reinstated contextual feature forms the basis of the source decision (i.e., voice cues in a voice discrimination task), and the present study shows that contextual cues that reinstate a feature that is orthogonal to the tested feature have no effect on performance. This suggests that only the reinstatement of criterial attributes will benefit source memory; however, a study that directly compares criterial and non-criterial context cues is needed to firmly support this conclusion. For example, a study could evaluate the influence of the font cues used in this experiment when both font and location memory is tested. If criterial context cues are more effective than non-criterial cues, than font reinstatement should enhance font memory and have no effect on location memory.

The memory state data reveal that recollecting contextual details has clear predictive value for subsequent source accuracy. Furthermore, the predictive value translated across memory attributes; that is, location source accuracy was higher when attributes other than location were recollected during recognition. This study also shows that the relationship in memory for various attributes is not limited to sensory details. Recollecting non-sensory features such as associations was also associated with enhanced location memory. The memory-state data are important, because they reveal dependencies in the encoding, storage, and/or retrieval of source features from multiple aspects of an encoded event. Although this relationship can be characterized as one feature cueing access to another, it is also possible that the relationship arises because of an underlying dimension of memory strength that influences source memory for both dimensions. Future research can discriminate between these two accounts by including test manipulations that should moderate the effect of retrieval cues and determining if these variables alter the dependency in memory for the two dimensions. For example, source memory could either be tested in an alternating format in which people make both source decisions (e.g., font and location) as each word appears, or tested in a blocked format in which people go through all of the words making a single source decision (e.g., font) then go through the list again making the other source decision (e.g., location). If the dependency between the two sources arises because retrieved font attributes cue location attributes, the cueing benefit should quickly fade once the cue has been removed. Thus, the dependency between font and location memory should be observed on the alternating test in which there is no delay between the two decisions, but not on the blocked test in which many intervening items separate the font and location decisions for

a given item. In contrast, if the dependency arises because people tend to remember both source features for strong items and neither source feature for weak items, then memory for the two features should be dependent regardless of the test format.

Although much future work is needed to clarify the true relationship among source features surrounding an event, the lack of convergence between the memory state data and the external cueing data of the present experiment suggests that a relationship of mutual cueing may not provide an adequate explanation of the dependency in memory performance for various source attributes. If it is indeed the case that recollected contextual features can serve as cues to other source features, future research is needed to firmly establish this causal link.

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APPENDIX:

INSTRUCTIONS FOR THE RECOGNITION/SOURCE TEST

Your memory for the words presented to you earlier will now be tested. You will be presented with words that either did or did not appear earlier in the experiment, and you will have to decide whether or not you studied the words before. In addition, we are going to ask you to distinguish between different ways that you might decide that you studied a word:

Recollection: use this response when you decide that you studied a word because you remember some specific detail of seeing the word before.

Familiarity: use this response when you decide that you studied a word because the word is very familiar, and this feeling of familiarity lets you know that you recently saw the word. Using this response means that you CANNOT remember anything specific about seeing the word before, but you are confident that you did because the word is highly familiar to you.

Guess: use this response when you think that you studied a word, but you don't know for sure and feel like you are just guessing. Keep in mind that using this response means that you do think that you saw the word before, you are just very unsure about it.

New: use this response when you don't think that you studied a word before.

For the next decision, you will choose among 7 types of information that you may have recollected when deciding that a word was studied. For your "recollect" responses, this will give you a chance to indicate the type of specific detail that you remembered from the study phase.

ASSOCIATIONS: Select this category if you decided that you studied a word because you specifically remembered some other word that the test word made you think of. For example, if the test word is "dog," you may recollect that you associated this word with the word "cat" when you studied it.

OTHER THOUGHTS: Select this category if you recognized a word because you were able to recollect something specific that you were thinking about when you studied the word. This category is called "OTHER THOUGHTS" to help you distinguish it from the "ASSOCIATIONS" category. Use the "OTHER THOUGHTS" category if you recollected anything that you thought about *other than an associated word*. If you recollected thinking of an associated word, use the "ASSOCIATIONS" category.

FONT SIZE: Select this category if you decided that you studied a word because you recollected the size in which it appeared when you studied it.

ORDER: Select this category if you recognized a word because you recollected the position of the word in the list. For instance, you may recollect that you saw the word at the beginning, middle, or end of the list.

LOCATION: Select this category if you decided that you studied a word because you recollected the location in which the word appeared on the screen when you studied it.

IMAGES: Select this category if you decided that you studied a word because you recollected a specific image that you formed when you studied the word.

OTHER: Select this category if you recollected information that does not fit into any of the categories provided above. This could be a wide variety of information, but remember that it has to be something SPECIFIC. For instance, you may recollect a sound you heard outside when you studied a word, or that you sneezed right before you saw a word.

Please keep in mind that we are not asking you select every type of information that you CAN recollect for a particular word, only the types of information that you DID recollect when you were deciding whether or not you studied the word. In other words, we only want you to select the types of information that you used to help you decide that the word was old. If you used more than one type of information to make your decision, select all of the appropriate categories.

There will be times when you decided a word was old without using recollected information—in these cases, you will have already indicated that you recognized the word on the basis of familiarity or a guessing process. For these words, do not select any of the categories of information.

Finally, after you select the types of information you recollected, you will be asked to make one more judgment about the words that you recognize. You will be

asked to indicate whether the word appeared on the top half or the bottom half of the screen when you saw it in the study phase. You are to press the red sticker to indicate the word was on the top of the screen and the yellow sticker to indicate that the word was on the bottom of the screen.

VITA

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