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Source Memory in the Absence of Successful Cued Recall

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Five experiments were conducted to address the question of whether source information could be accessed in the absence of being able to recall an item. The authors used a paired-associate learning paradigm in which cue–target word pairs were studied, and target recall was requested in the presence of the cue. When target recall failed, participants were asked to make a source judgment of whether a man or woman spoke the unrecalled item. In 3 of the 5 experiments, source accuracy was at or very close to chance. By contrast, if cue–target pairs were studied multiple times or participants knew in advance of learning that a predictive judgment would be required, then predictive source accuracy was well above chance. These data are suggestive that context information may not play a very large role in metacognitive judgments such as feeling-of-knowing ratings or putting one into a tip-of-the-tongue state without strong and specific encoding procedures. These same results also highlight the important role that item memory plays in retrieving information about the context in which an item was experienced.

Keywords: source monitoring, context memory, metacognition

Information about the contextual details surrounding an event is used in a variety of everyday tasks. That information can be used to verify that a memory is actually of something that occurred rather than merely imagined, to avoid repeating material to someone, to aid in identifying why a face looks familiar, to assess the credibility and/or plausibility of information stored in memory, to avoid unconsciously plagiarizing another person's ideas, or to confirm that an action such as locking one's door does not need to be checked, and it can be used in a variety of other tasks that are critical to normal human functioning. Broadly speaking, source-monitoring decisions can be made heuristically or more deliberately depending on the mental agenda of the person at the time memory is queried (Johnson, Hashtroudi, & Lindsay, 1993; Johnson & Raye, 1981). However, both types of source decisions are made by one's inspecting memory for evidence of qualitative characteristics such perceptual details, spatiotemporal information, records of elaboration or organization, and emotional reactions, to name a few. If there are sufficient qualitative characteristics stored in the memory trace that are consistent with a particular source, then an attribution is made in favor of that candidate over other competing, alternative sources. This depiction of source monitoring as an attribution process is consistent with researchers who believe that source judgments can be made on the basis of partial information (e.g., Dodson, Holland, & Shimamura, 1998; Gruppuso, Lindsay, & Kelley, 1997; Hicks, Marsh, & Ritschel, 2002; Qin, Raye, Johnson, & Mitchell, 2001; Slotnick & Dodson, 2005). By contrast, others believe that source information comes to the rememberer in a recollective and all-or-none fashion (e.g., Guttentag & Carroll, 1997; Quamme, Frederick, Kroll, Yonelinas, & Dobbins, 2002; Yonelinas, 1999).

Although we do not intend to weigh in on this debate, that theoretical issue raises an interesting question; namely, is source information among the partial information that contributes to such judgments as feelings of knowing (FOK)? In one laboratory variant of a typical FOK task, participants learn cue–target paired associates for a cued-recall test (e.g., Hart, 1967; Maki, 1999; Schreiber, 1998). When cued recall fails, participants rate their predicted ability to be able to recognize the cue among distractor items. The bulk of the research indicates that FOK judgments are accurate, as indicated by a positive gamma correlation between the predictions and ultimate recognition performance (e.g., Dunlosky & Nelson, 1992; Nelson, 1984). In the present study, we used the cued-recall paradigm to investigate whether participants could accurately predict from which of two sources the target had been presented when the target was not accessible to be recalled. In the terminology of Tulving and Pearlstone's (1966) citation classic, we investigated whether source information about the target was available even though the target itself was not accessible to be recalled. To be concrete, if *garden–boat* were a studied cue–target pair, and *boat* was spoken in a male or a female voice, when recall of *boat* failed in the presence of the cue *garden*, we wanted to assess whether participants possessed any source information about the target *boat*.

We assume, as have many others before us, that a memory trace is composed of a bundle of features of various types (e.g., Anisfeld & Knapp, 1968; Bower, 1967; Smith, Shoben, & Rips, 1974) and

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associations among them. In the present case, when a cue is presented and recall fails, one could assume that the strength of the cue–target association may mediate one's being able to retrieve partial information about the episodic context. Moreover, the strength of the target–context association, or stated alternatively as the binding of context information to other target information, could also mediate performance. Evidence against the first assumption comes from studies that demonstrated that increased memory performance is not associated with changes in FOK judgments (e.g., Jameson, Narens, Goldfarb, & Nelson, 1990). By inference, strengthening the cue–target association alone does not affect the amount or quality of the partial information that might contribute to judgments such as FOKs or tip-of-the-tongue (TOT) states (for a form of an exception see Schacter & Worling, 1985). Nevertheless, in the present experiments, we presented some paired associates once and others three times to investigate whether this manipulation has any influence on participants being able to specify the source of the unrecalled target item. To investigate the target–context association, we had some participants encode source information incidentally and others encode it intentionally. We also preexposed people to the target items in the source that they would later study them, in an attempt to increase the target–context information on the assumption that this would increase access to partial information about the source of the unrecalled target.[1]

Experiment 1

This first experiment served as an initial investigation of whether any context information is available about a target word that cannot be retrieved. We tested two conditions, one with incidental learning of context information and the other with intentional learning that their memory would be tested on the speaker's voice (male vs. female) for the target item. Under incidental learning, the binding of source information to the target should be weaker than under intentional instructions (e.g., D'Argembeau & Van der Linden, 2004). In this case, we predicted that participants might have no access to context information about the unrecallable target, but they might have partial details under intentional learning of source information. However, access to context information may require the target itself, in which case, a total absence of any ability to specify the source of the target before recognizing it is another viable prediction. That is, even under intentional encoding, predictive source monitoring may be at chance levels of performance because the item is inaccessible.

Method

Participants. Undergraduate students from the University of Georgia volunteered in exchange for partial credit toward a course research requirement. Each participant was tested individually in sessions that lasted approximately 30 min. Sixty-eight participants were randomly assigned to one of the two between-subjects conditions defined by intentional versus incidental learning of the source (with $N = 34$ in each). One participant with 0% cued recall and near-chance recognition accuracy was replaced because it appeared that the individual was responding randomly.

Materials and procedure. Eighty words were identified that could be split evenly into two sets that were equated on standard learning variables such as word frequency, length, number of syllables, and so forth. One set of 40 words was used as the cues, and the other set of 40 words was used as the targets (i.e., not counterbalanced). Software was written that randomly paired anew, for each participant tested, one cue word with one target word (all of these programs were written in Pascal; Jensen & Wirth, 1991). In this fashion, participants learned 40 paired associates. These paired associates were presented at a rate of 1 pair every 5 s during learning. A warning tone and fixation point initiated each study trial; 250 ms later, a cue word appeared in the center of the computer monitor, and 500 ms later, participants heard a prerecorded, digitized target word played over the computer's speakers. Twenty of the pairs had their target spoken by a male voice, and for the other 20 pairs, it was spoken in a female voice. Any given target word had a 50% chance of being spoken by the male or the female voice, because source assignment was done randomly anew for each participant tested. Participants in both conditions had been informed that they should learn the word pairs in preparation for being able to recall the spoken word when provided the written cue word. Only the participants in the intentional learning condition were told that they would also have to pay attention to the voice of the speaker because their memory for that variable would be tested as well.

At the conclusion of the study phase, a 5-min distractor task was administered. Participants were then informed of the nature of the test phase. For each cue word, participants were asked to type the target word or to press *Enter* if they could not recall it (for a similar procedure, see Hicks & Marsh, 2002). The computer provided feedback about whether they were correct, and in those cases when they were incorrect, they were asked to specify by pressing one of two keys whether the male or female voice had spoken the target item (which we will hereafter be calling a predictive source judgment, as discussed in Footnote 1). When they correctly recalled the target, they made a source-monitoring judgment as to whether the male or female voice had spoken the item, and the next test trial ensued by participants pressing one of the same two keys. In those cases when they could not recall the target, they had to choose the target from among three distractor items (i.e., a four-alternative recognition judgment). We used nonstudied distractors in this test because we did not want recognition to be based only on recollection of the entire associative structure of the cue–target pair. As Hicks and Marsh (2002) have argued, if source monitoring can be performed using partial information, we wanted not to make recognition based almost solely on recollection but rather to have the recognition decision be based also on partial information. After choosing one of the four alternatives as the target word, participants were asked to specify the source for it (i.e., male or female voice). After doing so, the next test trial appeared. Every paired associate that was learned was tested, and thus, there were 40 test trials presented in a different random order from the study sequence.

All instructions were displayed on the computer monitor at both study and test. After participants read those instructions, the experimenters

[1] Some readers may object to our terminology. However, we have chosen to call our source judgment predictive in the sense that participants are specifying a source for target items that they cannot recall but will later identify in a recognition test at very high rates. We could have easily labeled this a remote association between the cue and the source of the unrecalled target item. However, changing a label for a phenomenon does not change the essential character of what is being studied. Consequently, we have labeled our judgment a prediction in the absence of the target item being accessible for recall. In a similar way, we have chosen to define context as the male and female sources in the experiments that we report. Technically, in the intentional encoding manipulations in these experiments, a source is no longer a contextual detail because it is in the focus of attention during learning. To avoid using different terms for the intentional versus incidental conditions, we still refer to sources as contextual details even when they are a part what is intentionally encoded. The reader should understand that some might object to this nomenclature.

always verbally reiterated the instructions using their own words. Participants were not allowed to proceed with a task until the experimenter was convinced that they knew what was being asked of them. Nevertheless the experimenter remained in the testing room throughout to answer the random question that might have arisen.

Results and Discussion

Unless specified otherwise with an explicit *p* value, statistical significance by chance does not exceed the conventional Type I error rate of 5%. The data are summarized in the upper portion of Table 1. We first consider accurate cued recall and source memory and then report the data for the unrecalled targets. Participants recalled an average of about one third of the targets in the presence of the cue, and that performance was not a function of assigned condition (incidental vs. intentional learning of source), $t(66) = 1.14$, *ns*. This overall level of cued recall matches that found by Hicks and Marsh (2002). There was a numerical disadvantage for cued recall (3%) in this experiment (which persisted in subsequent experiments) when participants intentionally encoded the source information on the target. Most likely, focusing on learning the voice of the target slightly disrupted participants from forming an association between the cue and target words. As expected, source memory for the recalled targets was better under instructions to learn that information, $t(66) = 4.47$. However, according to one sample *t* test, it was above the chance level of 0.5 under incidental encoding, $t(33) = 2.44$.

When cued recall failed, participants tried to specify the source of the target in the absence of knowing the word, then chose an alternative on a 4-item recognition test, and finally provided another source judgment in the presence of the chosen alternative. Given the distractors on the test, recognition of the targets was quite high and did not vary a as function of encoding condition, $t(66) < 1$, *ns*. We compared correct source-monitoring performance prior to participants seeing the recognition question (see the Predicted column in Table 1) with correct performance after they chose the target (see the Source column in Table 1). Postrecognition source monitoring is reported only for the approximately 90% correct recognition judgments so that the exact same items can be compared (thereby avoiding item selection effects). In a 2 (intentional vs. incidental) × 2 (pre- vs. postrecognition) mixed-model analysis of variance (ANOVA), the interaction between the variables was statistically significant, $F(1, 66) = 8.60$. As can be seen in Table 1, participants had virtually no ability to specify the voice of target word prior to answering the recognition question but could do so quite accurately after identifying the correct alternative, main effect, $F(1, 66) = 48.85$. The interaction arose because the postrecognition correct specification of source was higher after participants intentionally learned that material. Even after intentionally learning the source of the target, when cued recall failed

Table 1
Proportions of Cued Recall, Recognition Accuracy, Source Memory, and Predicted Source Memory in Experiments 1–4

	Correct cued recall				Failed cued recall					
	Proportion		Source		Recognition		Predicted		Source	
Experiment and condition	*M*	*SE*	*M*	*SE*	*M*	*SE*	*M*	*SE*	*M*	*SE*
Experiment 1										
Incidental	.34	.03	.57	.03	.88	.02	.50	.02	.56	.02
Intentional	.31	.02	.76	.03	.90	.01	.54	.02	.70	.02
Experiment 2										
Incidental										
Once	.32	.03	.67	.04	.89	.02	.52	.03	.59	.03
Thrice	.72	.03	.62	.03	.97	.01	.57	.05	.66	.05
Intentional										
Once	.27	.03	.79	.04	.88	.02	.54	.02	.63	.03
Thrice	.63	.03	.87	.02	.97	.01	.65	.04	.84	.04
Experiment 3a										
Incidental										
No preprocess	.26	.04	.62	.04	.89	.02	.53	.03	.61	.03
Preprocess cue–target	.62	.03	.59	.02	.96	.01	.51	.03	.60	.03
Intentional										
No preprocess	.12	.02	.79	.05	.83	.03	.53	.02	.64	.03
Preprocess cue–target	.54	.03	.72	.03	.96	.01	.49	.03	.64	.03
Experiment 3b										
Incidental										
No preprocess	.32	.04	.57	.05	.87	.02	.51	.02	.54	.02
Preprocess target–source	.37	.04	.61	.04	.95	.01	.52	.02	.63	.03
Intentional										
No preprocess	.20	.02	.68	.05	.83	.02	.51	.02	.65	.03
Preprocess target–source	.27	.03	.79	.04	.93	.02	.51	.03	.81	.02
Experiment 4										
Once	.12	.02	.75	.06	.83	.03	.60	.03	.69	.03
Thrice	.46	.04	.90	.03	.95	.02	.73	.03	.83	.04

participants could not specify the context of target much above chance (4%), but the one sample t test against chance declared that even this level of accuracy was statistically significant, $t(33) = 2.64$. However, the simple t test between the two conditions for source accuracy prior to recognition was not significant by conventional standards, $t(66) = 1.85$, $p = .07$. So, depending on how one carves up the variance, 54% is either above or at chance performance.

The data from this first experiment clearly demonstrate that the partial information retrieved when cued recall fails does not uniquely identify context information. We infer from this that the memorial information retrieved does not contain very much contextual information. On the basis of prior work with FOK judgments, that information may identify semantic, perceptual, and structural properties of the word itself (Koriat, 1993, 1995; Koriat & Levy-Sadot, 2001; Koriat, Levy-Sadot, Edry, & de Marcas, 2003) but does not appear to be sufficient to support determining a contextual detail of the encoding phase. We find this result particularly striking in the case of intentional learning of the voice associated with the target item. Therefore, even when participants bind source information to the target, they cannot retrieve much, if any, partial information in the presence of only the cue that specifies the target's original context. Either the cue–target association or the target–context association is too weak to evoke such details. Therefore, in the next experiment we manipulated the number of times participants studied word pairs and whether they knew that they would be tested on the source of the target.

Experiment 2

Jacoby and his colleagues have argued that multiple study trials increase both recollection and familiarity (e.g., Jacoby, 1999; Jacoby, Jones, & Dolan, 1998). Therefore, we reasoned that thrice-presented pairs may have some access to context information when recall fails as compared with pairs studied only once, as tested in Experiment 1. Obviously, multiple-study trials strengthen both the cue–target association and the target–context association, and thus, we would not be able to uniquely specify the locus of any increased access to partial contextual information just by comparing once- with thrice-studied pairs. However, if the intentional learning manipulation strengthens only the target–context association, then by manipulating both the intention to study source and the number of presentations, we may be able to isolate better what supports making above-chance source judgments in the absence of one's being able to recall the target item itself. To these ends, participants studied paired associates either once or three times (within subject), and two different groups of participants received either the incidental or intentional encoding of voice instructions that were used in the previous experiment.

Method

Participants. Undergraduates from the University of Georgia volunteered in exchange for partial credit toward a course requirement. Each participant was tested individually in sessions that lasted approximately 30 min. Participants were quasi-randomly assigned to either the intentional or incidental learning conditions on the basis of their arrival time at the laboratory. There were 34 volunteers in each condition. Two participants were replaced for the same reasons described earlier.

Materials and procedure. In all of its essential properties, save one, this experiment was identical to the preceding one. The critical difference was that the software was revised to present half (20) of the pairs three times during learning, whereas the other half received only a single study trial as in Experiment 1. Therefore, instead of 40 study trials, participants experienced a total of 80 study trials in an entirely random sequence. In all other respects, the procedural details conformed to those already described for Experiment 1.

Results and Discussion

The results are summarized in the next section of Table 1. Cued recall for once-presented items was at a comparable level to that in Experiment 1. The data were analyzed with a series of 2 (within subject: once vs. thrice presented) × 2 (between subjects: incidental vs. intentional encoding of source) mixed-design ANOVA models. As expected, cued recall was much better after participants studied the items three times as compared with once, $F(1, 66) = 456.58$. There was also a negative effect of intentionally encoding source information; namely, focusing one's attention on the voice of the target item reduced encoding of the cue–target association, which reduced cued-recall performance. However, that effect was not statistically significant by conventional standards in this experiment, $F(1, 66) = 3.16$, $p = .08$ (cf. Experiment 1). Turning to source memory, performance for these recalled targets was better under intentional learning of source information, $F(1, 66) = 25.81$. However, there was an interaction between numbers of study trials and intention to learn, $F(1, 66) = 5.06$. Under incidental instructions, number of study trials did not affect source memory, $t(33) = 1.14$, *ns*, but under intentional instructions, more study trials increased source memory, $t(33) = 2.11$. There was no main effect of numbers of presentations on source memory for these recalled items.

The reader should note that in all of our comparisons of once-presented versus thrice-presented items, different numbers of items are being compared across the conditions. For example, participants' recognition of the target after failing to be able to recall it was high and on ceiling for thrice-presented items. There still is variability in those judgments, so parametric tests can be performed on that data, although we acknowledge the pitfalls of placing too much weight in such an analysis because it can be affected by item selection effects across the once- versus thrice-presented items. Nonetheless, and not surprising, three presentations lead to more accurate recognition judgments than did only studying a paired associate once, $F(1, 66) = 37.65$. Neither the main effect of intention to learn nor the interaction was statistically significant. In the 2 (intentional vs. incidental) × 2 (once vs. thrice) × 2 (pre- vs. postrecognition) analysis on the source judgments, accuracy was higher after recognition than it was in the absence of target identification before recognition, $F(1, 66) = 14.46$, which is an outcome that replicated Experiment 1. Also, source accuracy was greater under intentional learning instructions, $F(1, 66) = 5.59$, and after three presentations than one, $F(1, 66) = 26.40$. No other terms in the model were statistically significant. Because our interests lay mainly in understanding whether participants had access to partial source information prior to recognizing the target, we took the postrecognition source accuracy out of the model and tested the reduced model (i.e., the predictive judgments only). Only the number of presentations influenced participants' accuracy, $F(1, 66) = 5.92$, and not intention to learn, $F(1, 66) = 1.66$, *ns*. On the basis of the ANOVA results, we pooled over intention to learn and conducted one-sample tests against chance only to find that participants' predictive source judgments were at chance for once-presented pairs, $t(67) = 1.65$, $p = .10$, but above chance for thrice-presented pairs, $t(67) = 3.27$. Therefore, increasing the number of presentations allowed participants to gain access to partial information about context information in the absence of being able to recall the target word.

The results from this experiment indicate that contextual information may be among the partial recollective details available when recall of target information fails but that outcome will depend on whether the context information was particularly well learned. Although the ANOVA models declared that numbers of presentations trumped the intentional learning manipulation, the astute reader will see that access to partial information about the context for once- versus thrice-presented items was numerically greater under intentional than incidental instructions (differences of 11% and 5%, respectively, in the Predicted column in Table 1). Thus, intention to learn may still be a very important variable, as it may be responsible for the effect of numbers of presentations. That point aside, the general conclusion that should be drawn from Experiments 1 and 2 together is that context information may contribute to partial information about an unrecallable target only if that context information is salient and/or well learned during the study episode.

Experiments 3a and 3b

The previous experiment was informative insofar as it demonstrated that predictive source judgments can be well above chance when pairs are learned multiple times. Unfortunately, numbers of presentations did not interact with intention to learn the target–context associations. Thus, we still do not know whether the higher predictive ability in the absence of target recall from the multiple presentations in Experiment 2 is localized to increasing cue–target associations, target–context associations, or both. As a consequence, we conducted two additional experiments that we report together for brevity. Both experiments contained a preprocessing phase in which participants learned either the cue–target association alone (e.g., *garden–boat*) or the target–context association alone (e.g., *boat* spoken in a female voice). In Experiment 3a, participants studied half (20) of the cue–target pairs visually two times before experiencing the visual cue with the auditory target. This manipulation bears some resemblance to the half of the pairs being studied three times, except that in Experiment 3a two of these study trials only strengthened the cue–target association without the benefit of the source of the target being revealed. By contrast, in Experiment 3b the preprocessing phase consisted of presenting half of the targets in isolation twice in the voice that would be heard eventually when the cue was seen visually. Across both experiments, all participants received only one study trial in which the visual cue was paired with the target spoken in a male or female voice; however, in Experiment 3a the cue–target association was prestrengthened, and in Experiment 3b the target–context association was prestrengthened. Because in both Experiments 1 and 2 we manipulated intention to learn the source of the target, we believed it would be prudent to repeat that manipulation in both of the following experiments as well. If strengthening either of these two associations in and of itself leads to higher predictive source accuracy, then either Experiment 3a or 3b should show predictive accuracy above chance. If neither experiment shows this, then one can infer on the basis of the results of Experiment 2 that strengthening both types of associations simultaneously through multiple study trials is needed to find above-chance predictive source accuracy for unrecallable targets.

Method

Participants. University of Georgia undergraduates volunteered in exchange for partial credit toward a course research requirement. Each participant was tested individually in sessions that lasted approximately 30 min. Experiment 3a comprised 70 participants who were evenly split between the incidental and intentional learning conditions. Experiment 3b comprised 66 people, with 34 tested under incidental learning and 32 tested under intentional instructions to learn the source of the targets.

Materials and procedure. The software used in Experiment 2 was updated to present 40 preprocessing trials for use in Experiments 3a and 3b. In Experiment 3a, the software randomly selected 10 trials with a male target voice and 10 trials with a female target voice for preprocessing. These 20 trials were then studied twice as visual cue–target pairs presented in the center of the computer monitor for 5 s each. Following this preprocessing of the cue–target relationship, 40 trials (20 preprocessed and 20 new) ensued in which the cue was seen visually and the target was heard auditorially. The scheme was identical for Experiment 3b, except that rather than seeing the cue–target pair visually, only the targets were heard auditorially in the preprocessing phase. As such, eventually when the cue was seen and the target was heard for all 40 trials, half of the items had targets that had been previously experienced twice already in the same voice being used to study the entire cue–target constellation. About half of the participants in each experiment knew that the source of the target word would be tested, and the other half did not. In all other procedural respects, these experiments were identical to those reported previously.

Results and Discussion

The results of each experiment are summarized in the labeled sections of Table 1. In each experiment, the data were analyzed with a series of 2 (incidental vs. intentional learning of source) × 2 (preprocess an association vs. not) ANOVA models unless otherwise noted. In terms of accurate cued recall, strengthening the cue–target association in Experiment 3a increased cued recall, as would be expected, $F(1, 68) = 327.00$. Replicating Experiment 2, the intention to learn source information drew attentional resources away from learning the cue–target association, thereby reducing cued recall, $F(1, 68) = 7.76$. In Experiment 3b, preprocessing the target–context association also aided cued recall, $F(1, 64) = 12.70$, but clearly not as dramatically as preprocessing the cue–target association. As with the previous experiments, intention to learn source information reduced cued recall in Experiment 3b, $F(1, 64) = 6.81$. Source memory for these retrieved targets was positively affected by the intention to learn that information in both Experiment 3a, $F(1, 57) = 11.34$, and Experiment 3b, $F(1, 60) = 6.37$ (note that the degrees of freedom reflect a small data loss when there is no source memory score for either preprocessed or nonpreprocessed items). None of the other terms in the model for either experiment was statistically significant.

After failing to recall the target item, recognition of it was quite high given the nature of the distractor items. However, better recognition was obtained with preprocessing the cue–target association in Experiment 3a, $F(1, 66) = 46.45$, as well as the target–context association in Experiment 3b, $F(1, 64) = 34.07$. None of the other terms in the models were statistically significant. Neither of these outcomes is terribly surprising, because prior exposures should increase the familiarity of the target items, thereby aiding recognition memory. The critical analysis is the 2 (intentional vs. incidental) × 2 (preprocess vs. not) × 2 (pre- vs. postrecognition) ANOVA on source judgments comparing predictive source memory with source memory in the presence of correctly selecting the target item on the recognition test. In Experiment 3a, in which the cue–target relationship was prestrengthened, only the main effect of source accuracy being lower in the predictive stage and higher after selecting the correct target was statistically significant, $F(1, 66) = 31.36$. In Experiment 3b, in which the source–target association was prestrengthened, the same main effect was qualified by two interactions involving the pre- versus postrecognition variable. One interaction was with the intention-to-learn variable, $F(1, 64) = 16.71$, and the other was with the preprocessing manipulation, $F(1, 64) = 16.99$. The best way of summarizing these interactions is as follows: Preprocessing the target source increased postrecognition accuracy, but especially so with the intention to learn source information, whereas neither variable (intention to learn source or preprocessing of target-context information) affected predictive source accuracy. In fact, in the reduced ANOVA models for just the predictive source accuracy within each experiment individually, there were no statistically significant effects at all.

As the reader can see by scanning down the Predicted column of Table 1, neither preprocessing the cue–target association alone nor the target–context association alone raised predictive abilities above chance levels of performance (.50). Thus, neither association alone enabled a rememberer to gain access to context information about an unrecallable target item. By contrast, in Experiment 2, thrice presenting both the cue–target and target–context associations did increase such access well above chance, from which we conclude that context information needs to be very well learned before its partial access can reliably contribute to successful memory performance.

Experiment 4

The purpose of this final experiment was to test memory under "full disclosure" conditions of how the experiment would proceed. In other words, we informed participants that in the absence of being able to recall the target item, we were going to ask them to predict which source spoke that item. We also told them that after successful cued recall or after a recognition judgment, they would have to provide the source of the recalled or recognized target item. In doing so, we were attempting to see whether participants could form an association directly between the cue and the source of the target item. In this manner, we expected that participants might be able to raise their predictive accuracy even in the absence of being able to recall the cue. Because the experimental instructions were full disclosure, we did not manipulate intention to learn but only manipulated the number of times a studied pair was presented (once vs. thrice).

Method

Participants. Thirty-three University of Georgia undergraduates volunteered in exchange for partial credit toward a course research requirement. Each participant was tested individually in sessions that lasted approximately 30 min.

Procedure. The prestudy instruction files were updated to reflect the exact procedure that would be administered after learning. Participants were informed that the cue–target association was important for being able to recall the target in the presence of the cue. However, they were informed that if they could not recall the target, we would be asking them to make a prediction of which voice, male or female, spoke the target during learning. They were also informed that postrecall or postrecognition they would also be asked to specify the speaker of the target item. The software from Experiment 2 was modified to accommodate these changes. However, the once versus thrice study manipulation from that experiment was retained. Thus, participants saw the cue and heard the target once for half (20) of the studied items and three times for the other half of the studied items.

Results and Discussion

The data are summarized at the bottom of Table 1. Cued-recall performance was arguably quite poor for once-presented pairs as compared with various conditions in the previous experiments. This outcome is most likely a direct consequence of sacrificing some learning of the cue–target association in favor of the cue–context association. Nevertheless, cued recall was better for thrice-presented items than for once-presented items, $t(32) = 13.64$. As would be expected given the study instructions, source identification for successfully recalled targets was generally quite good, but better for thrice- than for once-presented pairs, $t(32) = 2.51$. As in previous experiments, failure to recall the target item resulted in high recognition rates that favored thrice- as compared with once-presented pairs, $t(32) = 5.68$. In the 2 (once vs. thrice) × 2 (pre- vs. postrecognition) ANOVA comparing predictive versus posttarget identification of source, both main effects were statistically significant, but there was no interaction. As in the previous experiments, source identification was better after recognition of the target as compared with predictive accuracy, $F(1, 32) = 19.20$. Moreover, thrice-presented pairs contained more source information than once-presented pairs, $F(1, 32) = 35.89$. This was true of both the predictive source judgments, $t(32) = 5.00$, as well as the postrecognition source judgments, $t(32) = 4.39$. In one-sample t tests against chance accuracy, predictive source accuracy for both the once-presented, $t(32) = 3.30$, and the thrice-presented pairs, $t(32) = 7.84$, were well above chance.

The outcomes from this experiment clearly demonstrate that participants can associate the source of targets with the cues when informed that they will be making predictive source judgments. Under these conditions, we would assume that source information would be available for other predictive judgments, such as FOKs. The major cost of doing so, as determined by cross-experimental comparison, is that some information about the cue–target association goes unlearned, thereby reducing cued recall. The identical outcome was observed in Experiments 3a and 3b, in which participants were intentionally encoding the source of the targets. Thus, as mentioned previously, attention directed at encoding source information reduces cued recall but does not necessarily guarantee that this information will be available for predictive judgments in the absence of the target (i.e., in Experiments 3a and

3b). We now turn to considering how these results fit more broadly against the fabric of source monitoring and item memory.

General Discussion

The empirical outcomes of this study are straightforward to summarize. Partial information about a target memory that cannot be recalled is sparse and generally insufficient to raise predictive accuracy from chance levels of performance. When the cue–target association and the target–context association are both simultaneously studied multiple times, the partial information retrieved does become accurately diagnostic of the target's source information. Experiments 3a and 3b clearly show that strengthening the cue–target association or the target–context association alone is insufficient to raise predictive accuracy from chance levels. When participants are told that source information about the target will be needed in the absence of successful cued recall, they can bind this source information into the cue deliberately, thereby raising predictive performance above chance. What these empirical results could imply is that the multiple presentations in Experiment 2 helped participants to encode more automatically an association between the cue itself and the context information of the target, thereby aiding predictive judgments about the source of the target.

Another implication of the results is that item information is an extraordinarily important mediator of being able to recover accurate source information. Virtually all studies of source monitoring present items back at test that were learned earlier and ask for a source discrimination, although notable exceptions exist (e.g., Chalfonte & Johnson, 1996). The main difference between other studies of source monitoring and the experiments presented here is that our interest was in the recovery of source information in the absence of being able to access the target item. We found that such recovery was generally poor unless participants took great care to study the information in preparation for such a test or if the pairs were presented repeatedly at encoding. Thus, source memory is primarily mediated by the semantic and perceptual reinstatement of the item as a copy cue. More remote associations between the cue and the target itself do not appear to mediate recovery of the context information of the target (Experiment 3a). For this reason, we have speculated that perhaps multiple presentations may create a more direct association between the cue and the target's context. One way to think about these results in terms of everyday source monitoring is recollecting that someone told you at the office party that annual raises would be very low next year, but you cannot remember the exact percentage. You have a good retrieval cue (raises discussed at office party) just as in the paired associate paradigm used here. However, failing to retrieve the exact percentage may also mean that you cannot discriminate whether it was Mary or John who imparted this information to you. The current results suggest that unless the person information was well encoded, your accuracy will be quite poor for retrieving partial information about the source in the absence of recalling the target memory.

The importance of item information in retrieving source information is a point that has been overlooked in the source-monitoring literature, perhaps because of the ubiquity of the paradigm used to test it. In unpublished work from our own laboratory, we have collected data that corroborate this point (Marsh, Hicks, & Cook, 2003). When homographs are studied with one semantic meaning such as *watch* as in *observe* versus *watch* as in *timepiece*, source memory is disproportionally hurt over item memory when the semantic context is changed from study to test. In other words, above and beyond the decrement to item memory that would be expected from the encoding specificity principle, source memory was reduced even more by the change in semantic meaning from study to test. In this sense, source monitoring is mediated by item information and not easily mediated by more remote associations such as the cue–target association tested here. Further corroborating this point are all of the analyses of the pre- versus postrecognition source judgments demonstrating that postrecognition source performance was always greater. The direct implication of the foregoing is that binding processes at learning more closely link an item's source to the item itself, but not necessarily other contextual elements that could serve to cue recall of source information. To use the previous example, knowing that one learned about raises at an office party is less helpful than knowing that raises will be 2% if one needs to consult the source to verify the veracity of one's memory.

The foregoing argument highlights one interim answer to our question; namely, is context information among the information that feeds into FOK judgments or TOT states? The answer is a qualified yes, with the qualification being that either people must study context information in a manner consistent with associating a cue with a target's source, or they must encode that information quite well, as in our manipulation of repeated study exposures. Probably in everyday episodic contexts in which unique pieces of information are imparted, the failure to recall a target memory will be associated with a failure to retrieve episodic details such as context information. Thus, context information can augment semantic, perceptual, associative, and orthographic information that is retrieved piecemeal when one is making an FOK judgment or assessing whether one is in a TOT state. However, it probably will not be the strongest piece of partial information among all of the partial information retrieved. Those who might take this view uncharitably could argue that the partial information retrieved is not criterial to making a predictive source judgment but that it is criterial to, say, increasing an FOK rating. Criterial information consists of mnestic details that are useful for performing a memory task, whereas noncriterial information cannot be used to perform the memory task at hand (Yonelinas & Jacoby, 1996). By this account, the partial context information that was not useful in making predictive source judgments could nevertheless be used to increase other metacognitive judgments. The tenet of Koriat's (1995) accessibility model that postulates that even incorrect information increases FOK ratings would be consistent with such an argument.

Finally, the results of this study are consistent with models of memory that argue that memory traces are bundles of features of various types that are associatively held together to one another in varying strengths (e.g., Bower, 1967). At retrieval, these features are reactivated, and if sufficient numbers in great enough strength can be revived, access to the target memory can succeed. However, even in the absence of accessing the target memory, features about the target memory can be retrieved at above-chance levels. Although participants in our study had difficulty in retrieving context information in the absence of recalling the target, we do not mean to imply that it will always be so. We have all had the experience of vividly remembering a conversation taking place at certain place, time, and location. We may not, however, be able to recall the content of the conversation. As such, access to contextual information can occur in the absence of item information, and the results of Experiments 2 and 4 are testaments to such occurrences. The outcomes of Experiments 1, 3a, and 3b do raise the question in our mind of just how often context information can be accessed in the absence of retrieving the semantic details of the item itself. Thus, studies of source monitoring which are primarily focused on people's memory for contextual details may be mediated more by the semantics of the stimulus materials than has been previously considered in this literature.

References

Anisfeld, M., & Knapp, M. (1968). Association, synonymity, and directionality in false recognition. *Journal of Experimental Psychology, 77,* 171–179.

Bower, G. H. (1967). A multi-component theory of the memory trace. In K. W. Spence & J. T. Spence (Eds.), *The psychology of learning and motivation* (Vol. 1, pp. 229–325). New York: Academic Press.

Chalfonte, B. L., & Johnson, M. K. (1996). Feature memory and binding in young and older adults. *Memory & Cognition, 24,* 403–416.

D'Argembeau, A., & Van der Linden, M. (2004). Influence of affective meaning on memory for contextual information. *Emotion, 4,* 173–188.

Dodson, C. S., Holland, P. W., & Shimamura, A. P. (1998). On the recollection of specific- and partial-source information. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 24,* 1121–1136.

Dunlosky, J., & Nelson, T. O. (1992). Importance of the kind of cue for judgments of learning (JOL) and the delayed-JOL effect. *Memory & Cognition, 20,* 374–380.

Gruppuso, V., Lindsay, D. S., & Kelley, C. M. (1997). The process-dissociation procedure and similarity: Defining and estimating recollection and familiarity in recognition memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 23,* 259–278.

Guttentag, R., & Carroll, D. (1997). Recollection-based recognition: Word frequency effects. *Journal of Memory & Language, 37,* 502–516.

Hart, J. T. (1967). Memory and the memory-monitoring process. *Journal of Verbal Learning & Verbal Behavior, 6,* 685–691.

Hicks, J. L., & Marsh, R. L. (2002). On predicting the future states of awareness for recognition of unrecallable items. *Memory & Cognition, 30,* 60–66.

Hicks, J. L., Marsh, R. L., & Ritschel, L. (2002). The role of recollection and partial information in source monitoring. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 28,* 503–508.

Jacoby, L. L. (1999). Ironic effects of repetition: Measuring age-related differences in memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 25,* 3–22.

Jacoby, L. L., Jones, T. C., & Dolan, P. O. (1998). Two effects of repetition: Support for a dual-process model of know judgments and exclusion errors. *Psychonomic Bulletin & Review, 5,* 705–709.

Jameson, K. A., Narens, L., Goldfarb, K., & Nelson, T. O. (1990). The influence of near-threshold priming on metamemory and recall. *Acta Psychologica, 73,* 55–68.

Jensen, K., & Wirth, N. (1991). *Pascal user manual and report: ISO Pascal standard* (4th ed.) [Computer programming language manual]. New York: Springer-Verlag.

Johnson, M. K., Hashtroudi, S., & Lindsay, D. S. (1993). Source monitoring. *Psychological Bulletin, 114,* 3–28.

Johnson, M. K., & Raye, C. L. (1981). Reality monitoring. *Psychological Review, 88,* 67–85.

Koriat, A. (1993). How do we know that we know? The accessibility model of the feeling of knowing. *Psychological Review, 100,* 609–639.

Koriat, A. (1995). Dissociation knowing and the feeling of knowing: Further evidence for the accessibility model. *Journal of Experimental Psychology, General, 124,* 311–333.

Koriat, A., & Levy-Sadot, R. (2001). The combined contributions of the cue familiarity and accessibility heuristics to feeling of knowing. *Journal of Experimental Psychology: Learning, Memory & Cognition, 27,* 34–53.

Koriat, A., Levy-Sadot, R., Edry, E. & de Marcas, S. (2003). What do we know about what we cannot remember? Accessing the semantic attributes of words that cannot be recalled. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 29,* 1095–1105.

Maki, R. H. (1999). The roles of competition, target accessibility, and cue familiarity in metamemory for word pairs. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 25,* 1011–1023.

Marsh, R. L., Hicks, J. L., & Cook, G. I. (2003). *The role of "incidental" attributes in recovering source-monitoring information.* Unpublished manuscript.

Nelson, T. O. (1984). A comparison of current measures of the accuracy of feeling-of-knowing predictions. *Psychological Bulletin, 95,* 109–133.

Qin, J., Raye, C. L., Johnson, M. K., & Mitchell, K. J. (2001). Source ROCs are (typically) curvilinear: Comment on Yonelinas (1999). *Journal of Experimental Psychology: Learning, Memory, and Cognition, 27,* 1110–1115.

Quamme, J. R., Frederick, C., Kroll, N. E. A., Yonelinas, A. P., & Dobbins, I. G. (2002). Recognition memory for source and occurrence: The importance of recollection. *Memory & Cognition, 30,* 893–907.

Schacter, D. L., & Worling, J. R. (1985). Attribute information and the feeling-of-knowing. *Canadian Journal of Psychology, 39,* 467–475.

Schreiber, T. A. (1998). Effects of target set size on feelings of knowing and cued recall: Implications for the cue effectiveness and partial-retrieval hypotheses. *Memory & Cognition, 26,* 553–571.

Slotnick, S. D., & Dodson, C. S. (2005). Support for a continuous (single-process) model of recognition memory and source memory. *Memory & Cognition, 33,* 151–170.

Smith, E. E., Shoben, E. J., & Rips, L. J. (1974). Structure and process in semantic memory: A featural model for semantic decisions. *Psychological Review, 81,* 214–241.

Tulving, E., & Pearlstone, Z. (1966). Availability versus accessibility of information in memory for words. *Journal of Verbal Learning and Verbal Behavior, 5,* 381–391.

Yonelinas, A. (1999). The contribution of recollection and familiarity to recognition and source memory judgments: A formal dual-process model and an ROC analysis. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 25,* 1415–1434.

Yonelinas, A. P., & Jacoby, L. L. (1996). Noncriterial recollection: Familiarity as automatic, irrelevant recollection. *Consciousness and Cognition, 5,* 131–141.

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