Journal of Memory and Language 103 (2018) 44–57

Contents lists available at ScienceDirect

Journal of Memory and Language

journal homepage: www.elsevier.com/locate/jml

Are encoding/retrieval interactions in recall driven by remembering, knowing, or both?

Oyku Uner*, Henry L. Roediger III

Department of Psychological & Brain Sciences, Washington University in St. Louis, United States

ARTICLE INFO

Keywords:
Encoding/retrieval interactions
Remember/know
Recollection
Familiarity

ABSTRACT

Reinstating encoding conditions at retrieval typically enhances recall and recognition, but are encoding/retrieval interactions driven by remembering, knowing, or both? To address this question, we used the remember/know paradigm in two cued recall experiments that varied the match between encoding and retrieval conditions. Participants studied words with associate or rhyme cues and were tested with associate or rhyme cues, resulting in two match and two mismatch conditions. In both experiments, recall was generally higher in the match conditions relative to the mismatch conditions, especially with associate cues. We assessed retrieval experience by asking participants to judge whether they remembered, knew or guessed each word they recalled. We estimated recollection and familiarity from these responses, and we found that both processes contribute to increased recall when encoding and retrieval conditions match. Thus, both recollection and familiarity contribute to successful retrieval with powerful retrieval cues.

Reinstating aspects of encoding at retrieval serves as a powerful retrieval cue, and typically enhances recall and recognition. Numerous studies have demonstrated this effect (Tulving & Thomson, 1973; for a review see Roediger, Tekin, & Uner, 2017); however, little is known how encoding/retrieval interactions affect states of awareness during retrieval. For instance, when recall increases via reinstating learning conditions at test, are *remembering* and *knowing* equally responsible? The current study investigated this question by using the remember/know paradigm (Tulving, 1985) in cued recall experiments.

The finding that reinstating aspects of encoding during retrieval increases recall and recognition has typically been explained with the encoding specificity principle (Tulving & Thomson, 1973) and the transfer-appropriate processing framework (Morris, Bransford, & Franks, 1977). According to both, an effective retrieval cue for an event is one that taps into aspects of how the event was originally encoded. The match or overlap between the encoded event and the encoding of the retrieval cue is critical (Tulving, 1974). To the extent that a learning condition is appropriate to a subsequent test, and the encoding condition can transfer to the retrieval condition, retrieval will be more successful (Morris et al., 1977; Tulving & Thomson, 1973). Another important dimension of cues is whether they may trigger remembering of more than one item. If there is such cue overload (Watkins, 1975) or lack of diagnostic value (Nairne, 2002), recall will be reduced even if information in cues matches that in targets.

A study by Fisher and Craik (1977) demonstrated the importance of the encoding/retrieval match. Fisher and Craik conducted three experiments varying the match between encoding and retrieval. In their second experiment, participants studied pairs of words that were either associated (*alone-isolated*) or that rhymed (*alone-stone*), and they were tested with the same associate or rhyme cues, resulting in four conditions: associate cue at study-associate cue at test, associate cue at study-rhyme cue at test, rhyme cue at study-associate cue at test, and rhyme cue at study-rhyme cue at test. Fisher and Craik (1977)'s results revealed an interaction between encoding and retrieval conditions; recall in the matching conditions was higher than recall in the non-matching conditions. Several other studies published around the same time showed similar interactions between encoding and retrieval conditions using slightly different paradigms (see Jacoby, 1975; McDaniel, Friedman, & Bourne, 1978; Morris et al., 1977), and further support that powerful retrieval cues are ones that tap into the conditions in which encoding occurred. Similar effects have been reported many times since then (see Roediger et al., 2017). In the current study, we sought to investigate how retrieval experience changes when the match between encoding and retrieval varies rather than relying simply on measures of recall. Of interest was whether the increased recall when encoding and retrieval conditions match is related to increased remembering, knowing, or both, and whether this depends on the nature

* Corresponding author at: Department of Psychological & Brain Sciences, Washington University in St. Louis, One Brookings Drive, St. Louis, MO 63130-4899, United States.

E-mail address: uner@wustl.edu (O. Uner).

https://doi.org/10.1016/j.jml.2018.07.002
Received 3 March 2018; Received in revised form 5 July 2018

of the encoding/retrieval match (e.g., a semantic-semantic match relative to a rhyme-rhyme match). One hypothesis is that semantic matches will elicit recollection, due to meaningful processing, whereas rhyme cues may elicit more knowing via familiarity. However, this prediction is an extension of current theorizing (e.g., Yonelinas & Jacoby, 2012) rather than a strict prediction. Another straightforward prediction is that both recollection and familiarity will be enhanced by a match between encoding and retrieval. Surprisingly, few researchers have addressed the nature of retrieval experience in cued recall.

Tulving (1985) originally measured retrieval experience by having participants state whether they remembered or knew a recalled or recognized word to be on the list they studied. Remembering indicated that participants "'remembered' [the item's] occurrence in the list" and knowing indicated participants "simply 'knew' on some other basis that the item was a member of the study list" (Tulving, 1985, p. 8). Tulving argued that remembering and knowing tapped into different types of consciousness (autonoetic and noetic, respectively) that characterized different memory systems (episodic and semantic, respectively). Others held a unitary view of memory and considered remembering and knowing to be tapping into dual-components of recognition (Graf & Mandler, 1984; Jacoby, 1983; Mandler, 1980; Yonelinas, 2002). From this point of view, remembering is associated with a conscious recollective experience of an event, whereas knowing is associated with a feeling of familiarity in the absence of any recollective experience (Jacoby, 1991; Mandler, 1980; Yonelinas, 2002). Both contribute to recognition, and various experimental manipulations should change the extent to which one is used more dominantly during retrieval. Systematic investigations since Tulving (1985) have shown that some manipulations affect only remember but not know responses, some affect only know but not remember responses, and others have similar or even opposite effects on the two responses (see Roediger, Rajaram & Geraci, 2007, for a review), supporting the functional independence of these judgments.

The remember/know paradigm has also been used to estimate recollection and familiarity, where remembering is a proxy of recollection and knowing a proxy of familiarity. However, this practice assumes that these processes are mutually exclusive and that retrieval of an event cannot be driven by both. Jacoby, Yonelinas, and Jennings (1997) argued against this assumption and put forth the Independence Remember/Know (IRK) procedure that did not assume exclusivity, but rather considered these processes to be independent. Recall or recognition could be driven both by recollection and familiarity, and the IRK procedure permitted an estimate of the contribution of each process. In this procedure, recollection is measured by the proportion of remember responses. However, because familiarity would be underestimated using only know responses (because some familiarity should also contribute to remembering), familiarity in the IRK procedure is estimated by the proportion of know responses for trials in which participants do not pick the remember option (i.e., Know/(1-Remember)). Transforming know responses using this procedure seems to result in a more accurate estimate of familiarity independent of recollection (Jacoby et al., 1997).

The current study examined the contributions of both remembering and knowing, and recollection and familiarity to encoding/retrieval interactions. The few studies addressing this question using recognition do not converge on a conclusion. Some of these studies showed that encoding/retrieval interactions were driven by remembering. For instance, Macken (2002) manipulated the context in which participants studied items and then took a recognition test, collecting remember and know responses for each recognized item. Context was defined as a combination of color of the screen, color of the presented item and location of these on the screen. Participants studied items in one of two contexts and were tested on those items either in their old context or in a different context, which could be the other context from the study phase or a novel context. As expected, matching the context in which items were studied and tested increased recognition for both words and nonwords. Critically, the match in study and test contexts selectively increased recollection (as measured by remember responses) but did not affect familiarity (as measured by know responses transformed with the IRK procedure). Macken (2002) concluded that context effects in recognition memory occur only when recognition is accompanied by conscious recollection, but not when an item is recognized based on familiarity.

In a different study, Dewhurst and Brandt (2007) contrasted generation of five-letter words from four-letter fragments and reading intact five-letter words at learning and at test, and asked participants about their retrieval experience at test. Generating words during study increased recognition of words generated and read during test; more importantly, recognition memory was enhanced when the same words were also generated at test. Participants also indicated their retrieval experience by giving a remember, know or guess response after each word they recognized. Participants gave more remember responses when words generated during study were also generated at test, but not when words read during study were also read at test. Dewhurst and Brandt (2007) concluded that matching effortful encoding and retrieval conditions (i.e., generation) enhanced recognition memory and was accompanied by a conscious recollection of encoding (i.e., more remember responses), whereas matching more automatic encoding and retrieval conditions (i.e., reading) did not show a similar pattern. Matching certain study and test conditions enhances recognition and this is associated with an increase in only remember responses.

On the other hand, other studies showed that the increase in recognition when encoding and retrieval conditions match is driven by knowing. Gregg and Gardiner (1994, Exp. 2) matched or mismatched presentation modality (auditory vs. visual) at study and test, and showed that a match increased knowing, not remembering. In their study, words were presented rapidly in a visual format to half the participants, who were not informed of a subsequent recognition test. These participants were asked to count the number of words with blurred letters in the list (none of the words were blurred and these instructions were used to encourage close attention and somewhat superficial processing). The remaining half of the participants were informed of a subsequent recognition test and they studied the words at a slower presentation rate, again with visual presentation. All participants took a recognition test in which half of the words were presented visually (match) and the remaining half were presented auditorily (mismatch). After calling an item old or studied, participants indicated whether they remembered or knew the words. Gregg and Gardiner (1994) found that the group that was asked to count the number of blurred letters on the list showed higher recognition performance when the presentation modalities matched. Critically, this better recognition performance was accompanied by increased know responses, suggesting that reinstating some aspects of encoding at retrieval selectively increases know responses under certain circumstances (i.e., fast presentation and looking for surface features). The same outcome did not occur when the words were presented slowly under intentional learning conditions. Of course, this outcome of enhanced recognition being due to increased know responses does not necessarily conflict with the other two studies, because it may be due to the use of special study conditions.

Although these few studies asked what processes drive encoding/retrieval interactions using recognition, much less evidence exists using cued recall measures. However, there is no theoretical reason why this question cannot be addressed using recall tasks. In fact, given that most of the encoding specificity research is based on cued recall tasks (Tulving, 1983), it becomes imperative to examine the question of what processes drive the benefit of an encoding-retrieval match using recall tasks. The relatively few experiments using the remember/know procedure in recall experiments (though, not focused on encoding/retrieval interactions) have consistently shown that recall does not only rely on conscious recollection or controlled processing unlike some previous claims (e.g., Quamme, Yonelinas, Widaman, Kroll, & Sauvé, 2004). In fact, some knowing or familiarity also contributes even to free recall (Hamilton & Rajaram, 2003; McCabe, Roediger, & Karpicke, 2011; McDermott, 2006; Mickes, Seale-Carlisle, & Wixted, 2013; Tulving, 1985). Therefore, it is plausible to ask, in the context of recall, whether recollection, familiarity, or both drive the enhanced performance when encoding and retrieval conditions match.

In our experiments, we asked the question, "What processes drive the benefit of encoding/retrieval matches in cued recall?" Because some aspect of encoding is reinstated at retrieval, an encoding-retrieval match should enhance recollection of events, especially when the target event is specified by the cue (i.e., when cue diagnosticity is high). If so, participants should give more remember responses when retrieval cues match encoding conditions (relative to mismatch) whereas know responses should not necessarily be affected. Previous research on remember and know responses described such a claim in passing. For instance, Rajaram (1993) argued that "'remember' responses, by definition, require recollecting the study phase and reinstating its context" (p. 100). Similarly, for recognition, Dewhurst and Conway (1994) argued that "when these activated memories contain details of sensory and perceptual information, semantic information, and records of cognitive operations performed at study, then recognition memory is dominated by recollective experience" (p. 1098). Based on these ideas, and evidence from recognition memory experiments, we predicted that matching encoding and retrieval conditions that increases recall would increase conscious recollection. However, the studies just mentioned used semantic cues. As mentioned above, when rhyme cues are used, processes involving familiarity may drive know responding or even guessing. Since the evidence regarding familiarity is less conclusive, we did not predict that familiarity alone would drive encoding/retrieval interactions. However, other evidence from free and cued recall experiments suggest that knowing or familiarity may also be involved in enhanced recall (e.g., McDermott, 2006 and others cited above).

In both experiments, participants studied words with associate or rhyme orienting questions, and were tested with associate or rhyme cues, resulting in four within-subjects conditions: associate at study-associate cue at test (AA), associate at study-rhyme cue at test (AR), rhyme at study-associate cue at test (RA), rhyme at study-rhyme cue at test (RR). This design was based on the study by Fisher and Craik (1977, Exp. 2) discussed earlier, with the addition of asking participants to provide remember, know, or guess responses after each word recalled. Recall, remembering and knowing were then compared across conditions to see if reinstating encoding conditions increased recall and if so, whether remembering, knowing or both drove this increase. We expected to replicate Fisher and Craik's recall findings, with recall increasing when the cues at test matched the cues at study (i.e., AA, RR) compared to when the cues do not match (i.e., RA, AR). Critically, based on previous research in recognition memory experiments, we also predicted that the increase in recall when the cues match would be accompanied with increased remembering, but not necessarily knowing, especially with semantic cues. However, recall results cited above indicate that knowing could well be involved in enhanced recall, too, but evidence is lacking with regard to how encoding-retrieval matches would affect knowing for either semantic or rhyme cues.

Experiment 1

Method

Participants

One hundred eleven Washington University undergraduates from the Psychology Department's subject pool participated in the experiment. Mean age of participants was 20.1 and participant age ranged from 18 to 26. 97 of the 111 participants were native English speakers. The age at which the remaining 14 participants started learning English ranged from age 4 to 14.[1] The set sample size was 64 to double the sample size in Fisher and Craik's (1977, Exp. 2) study in order to increase power. Data from the additional 47 participants were collected in order to get a final sample of 64 participants who correctly explained the distinction between remembering and knowing. We excluded the participants who were unable to explain the distinction, and analyzing the data with the full sample did not change our conclusions. Any minor discrepancies in results are reported in footnotes. Participants were tested in groups of up to six and received either one course credit or $10 for their participation. The study was approved by Washington University's Institutional Review Board.

Materials

Eighty target words, their associates and rhymes, and words unrelated to them were selected using Nelson, McEvoy and Schreiber's norms (1998), the English Lexicon Project database (Balota et al., 2007) and an online rhyme dictionary (http://rhymezone.com). All words were four to ten letters long and had a minimum logarithmic frequency of 7 (identified via the English Lexicon Project database, see Balota et al., 2007). The target words were selected with the constraints that they had at least one associate with a minimum of 0.4 backward associative strength (i.e., the target word was produced as an associate from this word on at least 40% of the trials in an association task) and they had at least one rhyme. The materials can be found in Appendix A.

The study phase was a random presentation of forty associate orienting questions (e.g., *Is the following word associated to argue?*) and 40 rhyme orienting questions (e.g., *Does the following word rhyme with kite?*), followed by a presentation of the target word (e.g., *fight*).

For the distractor task between the study phase and the test phase, simple arithmetic problems were presented for three seconds each, until seven minutes were completed. The arithmetic problems were either a sum, subtraction, multiplication or division of two numbers between zero and ten.

The test consisted of a random presentation of thirty associate cue words (e.g., *argue,* for the target word *fight)* and 30 rhyme cue words (e.g., *kite,* for the target word *fight*). The cues corresponded to only one of the target words from the study phase and they either matched or mismatched the input condition.

The instructions regarding remembering, knowing and guessing were based on Gardiner, Ramponi, and Richardson-Klavehn (1998). A guess option was included so that the proportion of knowing would not be inflated with participants' guesses (Gardiner, Java, & Richardson-Klavehn, 1996; Gardiner et al., 1998). Participants were instructed to give a remember response "if recall is accompanied by some recollective experience," a know response "if recall is accompanied by strong feelings of familiarity in the absence of any recollective experience," and a guess response when they "think it possible that the word was presented but [they] are not sure that it was." The full instructions elaborated these points and can be found in Appendix B.

Design

Three independent variables were manipulated within subjects. Participants studied half of the 80 target words with associate orienting questions and studied the other half with rhyme orienting questions. The answer to 60 of these questions was yes (congruent trials), and the answer to the remaining 20 questions was no (incongruent trials). Participants were later tested only on the 60 target words from the congruent trials. The incongruent trials were used to keep participants on task during the study phase. Thus, during this phase, participants received an associated word with half of the target words (e.g., *sand* –

[1] The results did not change when non-native English speakers were excluded from our analyses, therefore the results reported in the main text include both native and non-native speakers of English.

beach) and a rhyming word with the remaining half of the target words (e.g., *honey* - *money*). At test, participants were provided with a rhyme or an associate for each target word from the study phase. Thus, there were four within-subjects conditions: associate at study-associate cue at test (AA), associate at study-rhyme cue at test (AR), rhyme at study-associate cue at test (RA), rhyme at study-rhyme cue at test (RR). AA and RR were match conditions, whereas AR and RA were mismatch conditions. All variables were counterbalanced such that each target word was presented with each orienting question and was tested with each test cue type an equal number of times across participants. After detailed instructions, all participants were asked to provide a remember, know, or guess response following each recall response. The dependent variables were proportion recalled in the four conditions, and the proportions of remember and know responses in the four conditions.

Procedure

All participants were tested on individual computers in groups of up to six. The experimenter began by briefly outlining the experiment and reading instructions regarding how to provide remember, know, and guess responses. The experimenter then asked one of the participants to repeat the distinction between remembering, knowing and guessing, to make sure all participants understood the instructions before they began the experiment.[2] The rest of the experiment was computerized, and relevant instructions and an example were presented on the computer screen before the study phase and the test phase.

During the study phase, participants saw eighty target words after either a rhyming or associate orienting question (half of each). The orienting questions were randomized for each participant. Each question was presented for three seconds and was followed by the presentation of a target word for two seconds. Each question asked whether the following target word rhymed with or was associated to the word provided in the question. Participants clicked the yes or no button on the screen after they were presented with the question and the target word, and the response was self-paced.

At the end of the study phase, participants solved simple arithmetic problems for seven minutes. The test phase followed the arithmetic problems. Before the test, participants were again provided with written instructions reminding them how to provide remember, know and guess responses for each word they recalled. Participants were then presented with cue words randomly, thirty of which were associate and 30 were rhyme cues. They were instructed to type in a target word from the study phase that the cue word reminded them of. Each cue word corresponded to only one of the target words in the congruent trials from the study phase. Recall was self-paced. After participants submitted each recall response or indicated retrieval failure with submitting a blank box, a screen with four buttons appeared. They were instructed to click NO RECALL if they had left the response box empty, and they were instructed to pick among the REMEMBER, KNOW, and GUESS buttons if they submitted a response. Providing this response was also self-paced.

After the test phase, participants completed a computerized, self-paced questionnaire regarding their experience during the experiment. Among other questions, they were given an open-ended question that asked how they distinguished among remember, know and guess responses, along with a text box. They were asked "At test, what led you to give a remember, know or a guess response? How did you distinguish between the three responses?". The responses to this question were scored and used to identify the participants who did not explain the distinction correctly. At the end of the questionnaire, participants were debriefed and thanked for their participation. The experiment lasted 32.6 min on average.

Scoring

Answers from the post-experimental questionnaire were scored to identify the participants who understood the distinction between remember, know and guess responses correctly. If a participant did not put in a response or did not explain the distinction correctly, they were given a score of 0. If participants explained how they distinguished between these judgments correctly, they were given a score of 1. Two raters scored all responses. Pearson's *r* showed reasonable agreement between the raters ($r = 0.81$, $p < 0.01$), therefore one of the rater's scoring was used for further analyses. The participants who were given a score of 0 were replaced until the set number of participants ($N = 64$) was obtained. However, as indicated below, excluding participants did not affect the results.

Strict scoring was used for the recall test by a computer programmed to recognize all letters of the target word for correct recall.

Results and discussion

Forty-seven participants with a score of 0 on the post-experimental question in explaining the distinction among remembering, knowing and guessing were replaced until a sample of 64 participants with a score of 1 was obtained (see Eldridge, Sarfatti, & Knowlton, 2002, for a similar procedure). This exclusion of participants did not change the results and is discussed later. Two participants from this sample of 64 were excluded from the analyses because they were not able to correctly recall any of the target words. Therefore, results reported below are based on 62 participants. Table 1 contains the descriptive statistics across the four conditions. The overall accuracy for answering the orienting questions in the study phase was 98%, but all items are included in our analysis. All omnibus tests of statistical significance used an alpha level of .05 and corresponding means are reported with 95% confidence intervals. Because many of the critical comparisons required post hoc tests to determine the nature of interactions, an alpha level of .001 was used for these comparisons and corresponding means are reported with 99.9% confidence intervals. Effect sizes are reported using partial eta-squared (η_p^2) for main effects and interactions, and Cohen's *d* for pairwise comparisons. The data (as well as materials and instructions) for both experiments can be downloaded from the Open Science Framework repository (http://osf.io/rzvec/).

Recall

The proportion of words correctly recalled was calculated for each of the four within-subjects conditions: associate at study-associate cue at test (AA), associate at study-rhyme cue at test (AR), rhyme at study-associate cue at test (RA), rhyme at study-rhyme cue at test (RR). Fig. 1 provides the proportion recalled in each condition. When participants answered associate orienting questions during study, they recalled more at test ($M = 0.46$, [0.44, 0.47]) compared to when they answered rhyme orienting questions ($M = 0.33$, [0.30, 0.37]), $F(1, 61) = 77.87$, $\eta_p^2 = 0.56$. This is another instance of the levels-of-processing effect (Craik & Lockhart, 1972; Craik & Tulving, 1975). Likewise, participants recalled more with associate words ($M = 0.61$, [0.57, 0.64]) than they did with rhyme words at test ($M = 0.18$, [0.15, 0.21]), $F(1, 61) = 283.52$, $\eta_p^2 = 0.82$. As Tulving (1979) argued, the nature of retrieval cues is likely as important or more important than encoding conditions in encoding-retrieval experiments.

The interaction between orienting question and test cue was also significant, $F(1, 61) = 262$, $\eta_p^2 = 0.81$. We predicted that recall in the matching conditions (AA and RR) would be greater than recall in both non-matching conditions (RA and AR). Participants recalled more in the

[2] The first thirty-four participants were not given verbal instructions prior to the experiment. Responses on the post-experimental questionnaire showed that 26 of these participants did not understand the instructions regarding how to provide a remember, know, and guess response correctly. Verbal instructions were provided for the remaining participants and the experimenter made sure participants understood the instructions correctly before they began the experiment.

Table 1
Descriptive statistics of proportions across conditions in Experiment 1.

	RR	RA	AR	AA
Recall	.33 *(.22)*	.33 *(.25)*	.04 *(.04)*	.88 *(.12)*
Remember	.20 *(.18)*	.06 *(.12)*	.01 *(.02)*	.67 *(.22)*
Know	.09 *(.10)*	.07 *(.09)*	.01 *(.03)*	.17 *(.16)*
Familiarity	.11 *(.14)*	.08 *(.11)*	.01 *(.03)*	.48 *(.33)*

Note. Standard deviations are reported in parentheses. RR: Rhyme study-Rhyme test; RA: Rhyme study-Associate test; AR: Associate study-Rhyme test; AA: Associate study-Associate test. The remember and know proportions are calculated by diving the number of responses in a condition by the total number of items in that condition. Familiarity is calculated with the remember and know proportions using the IRK procedure (K/(1-R)).

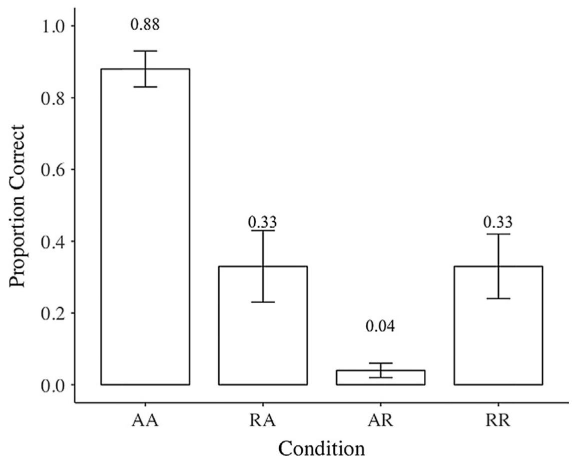

Fig. 1. Recall across the different conditions in Experiment 1. AA: Associate study-Associate test; RA: Rhyme study-Associate test; AR: Associate study-Rhyme test; RR: Rhyme study- Rhyme test. Error bars represent 99.9% confidence intervals.

AA condition compared to both the RA condition ($t(61) = 17.26$, $d = 2.78$) and the AR condition ($t(61) = 53.35$, $d = 9.32$). Participants also recalled more in the RR condition compared to the AR condition ($t(61) = 10.68$, $d = 1.82$), but not compared to the RA condition ($d = 0$).[3] Although we obtained the predicted interaction, we did not exactly replicate Fisher and Craik's recall results because of this last outcome.

Remember and know responses

Proportions of remember and know responses were calculated for each of the four within-subjects conditions by dividing the number of a response type in a condition (only counting correctly recalled items) to the total possible responses in a condition. Due to the low recall level in the AR condition, conclusions regarding remembering and knowing are limited; nonetheless, we report results from this condition for completion.

Fig. 2 shows the proportion of remember and know responses across conditions. The proportion of remember responses showed a similar pattern to the accurate recall responses. Participants gave more remember responses at test when they answered associate orienting questions during study ($M = 0.34$, [0.31, 0.37]) compared to when they answered rhyme orienting questions ($M = 0.13$, [0.10, 0.16]), $F(1, 61) = 253.36$, $\eta_p^2 = 0.81$. Likewise, participants also gave more remember responses at test when they recalled with associate words ($M = 0.37$, [0.33, 0.40]) than when they recalled with rhyme words

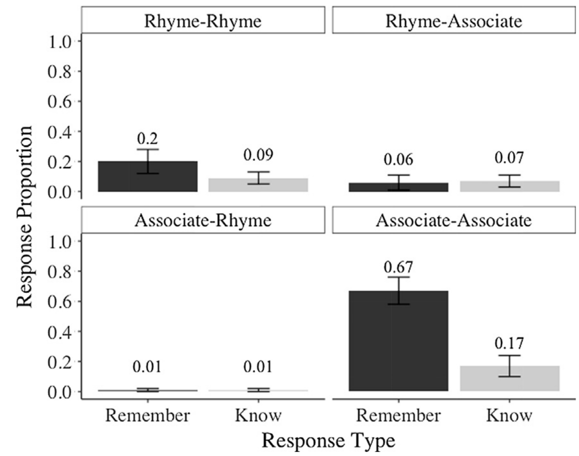

Fig. 2. Proportions of remember and know responses across the different conditions in Experiment 1. Error bars represent 99.9% confidence intervals.

($M = 0.10$, [0.08, 0.13]), $F(1, 61) = 255.95$, $\eta_p^2 = 0.81$. Critically the interaction between orienting question and test cue was also significant, $F(1, 61) = 376.85$, $\eta_p^2 = 0.86$. Participants gave more remember responses in the AA condition compared to the RA condition ($t(61) = 22.74$, $d = 3.41$) and the AR condition ($t(61) = 23.95$, $d = 4.19$). Participants also gave more remember responses in the RR condition compared to the AR condition ($t(61) = 9.02$, $d = 1.47$) and the RA condition ($t(61) = 5.59$, $d = 0.91$). These comparisons support the prediction that the increased recall when encoding and retrieval conditions match would be accompanied by increased remembering. Put another way, we replicated Fisher and Craik's (1977) recall results when examining remembering.

The proportion of know responses did not differ based on which orienting question participants answered during study. However, the test cue participants were provided did affect knowing, $F(1, 61) = 45.96$, $\eta_p^2 = 0.43$. Participants reported more know responses when recalling with associate words ($M = 0.12$, [0.10, 0.14]) compared to recalling with rhyme words ($M = 0.05$, [0.04, 0.06]). In addition, the interaction between orienting question and test cue was significant, $F(1, 61) = 25.35$, $\eta_p^2 = 0.29$. The proportion of know responses was greater in the AA condition compared to the RA condition ($t(61) = 3.88$, $d = 0.76$) and the AR condition ($t(61) = 7.54$, $d = 1.38$). The proportion of know responses was also greater in the RR condition compared to the AR condition ($t(61) = 5.54$, $d = 1.07$), but not the RA condition ($d = 0.21$).[4] This interaction is likely driven by the large recall difference between the AA and the AR conditions. The analysis of guess responses can be found in Appendix E; they are not discussed here because they are not of theoretical interest.

As mentioned in the Introduction, the Independence Remember/Know (IRK) Procedure is often used to obtain a better estimate of familiarity. According to Jacoby et al. (1997), remember responses can be taken as a measure of recollection; however, considering know responses as a measure of familiarity underestimates it, if the two processes are independent. Because familiarity also contributes to remembering under the independence assumption, Jacoby et al. introduced a new calculation that corrected for this: K/(1-R). By dividing the proportion of know responses by the opportunities participants did not make a remember response, a better estimate of

[3] Recall results of the full sample did not differ from the results reported here. See Appendix C for the table including means for all conditions for all participants.

[4] Results based on the proportion of remember responses of the full sample did not differ from the results reported here. The only difference was in the proportion of know responses. Know responses were significantly affected by the orienting questions during study, $F(1, 107) = 4.47$, $\eta_p^2 = .04$. Participants gave more know responses when they studied words with associate cues ($M = .10$, [.08, .12]) than when they studied words with rhyme cues ($M = .08$, [.07, .09]). See Appendix C for the table including individual means.

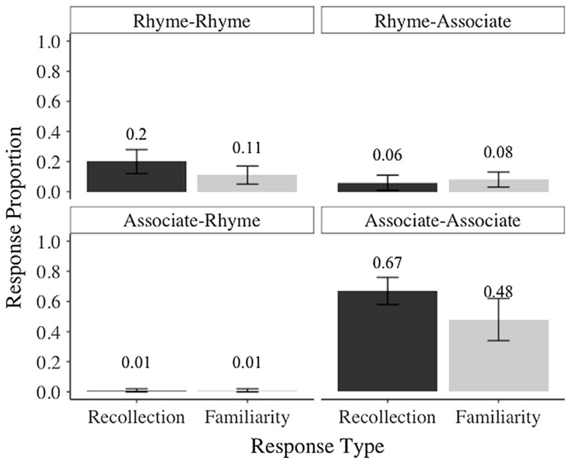

Fig. 3. Estimates of recollection and familiarity across the different conditions in Experiment 1 using the Independence Remember/Know (IRK) procedure. Error bars represent 99.9% confidence intervals.

familiarity can be obtained. Fig. 3 shows the proportion of remember responses (i.e., recollection) together with estimates of familiarity across conditions. Analyses of these estimates showed that familiarity at test was higher when participants answered associate orienting questions during study ($M = 0.25$, [0.20, 0.29]), compared to when they answered rhyme orienting questions ($M = 0.10$, [0.08, 0.12]), $F(1, 61) = 45.06$, $\eta_p^2 = 0.43$. Likewise, familiarity was higher when recalling with associate words ($M = 0.28$, [0.24, 0.32]) compared to recalling with rhyme words ($M = 0.06$, [0.05, 0.08]), $F(1, 61) = 110.65$, $\eta_p^2 = 0.65$. The interaction between orienting question and test cue significantly affected familiarity, $F(1, 61) = 81.07$, $\eta_p^2 = 0.57$. Familiarity in the AA condition was greater than in the RA condition ($t(61) = 8.53$, $d = 1.61$) and the AR condition ($t(61) = 11.19$, $d = 1.99$). Familiarity in the RR condition was greater compared to the AR condition ($t(61) = 5.63$, $d = 0.98$), but not compared to the RA condition ($d = 0.24$).[5] Overall, these results mimic those of accurate recall and remembering, though of course with lower estimates. Considering the estimates of recollection (remember responses) and familiarity (know responses transformed with the IRK procedure), the increased recall when encoding and retrieval conditions match is accompanied by both enhanced recollection and familiarity relative to the other conditions.

Experiment 2

Recall results of Experiment 1, particularly in the AR condition, differed from those reported by Fisher and Craik (1977, Exp. 2). One possible reason for the differences in recall is the specification of the nature of the test cues. Participants in Experiment 1 were presented with a word that either rhymed with or was associated to one of the words they studied (e.g., *wing* or *crown*, for the word *king*); however, the test did not explicitly state whether a cue word was a rhyme or an associate cue. This lack of specification may have caused participants to treat many (perhaps most) cues as semantically related to target words. Upon failure to retrieve a target word using semantic association, participants may have switched their strategy to generate a rhyme for the presented cue that would match one of the previously studied target words. If this hypothesis is accurate, it may have resulted in our failure to replicate the complete pattern of Fisher and Craik's results. Therefore, in Experiment 2, we specified the nature of the retrieval cues, as did Fisher and Craik (1977), to resolve this issue. Aside from this change, Experiment 2 had the same design, materials, and procedure of Experiment 1.

Participants studied words with associate or rhyme orienting questions and were tested on these words with associate or rhyme cues, resulting in the same four within- subjects conditions as in Experiment 1: associate at study-associate cue at test (AA), associate at study-rhyme cue at test (AR), rhyme at study-associate cue at test (RA), rhyme at study-rhyme cue at test (RR). Participants also provided a remember, know, and guess response after each word they recalled. An interaction between encoding and retrieval conditions was expected, whereby recall in the AA and the RR conditions was predicted to be greater than recall in both the AR and the RA conditions. As in Experiment 1, we predicted that the greater recall in the match conditions (i.e., AA and RR) would be accompanied mostly by increased remember responses.

Method

Participants

Ninety-two Washington University undergraduates from the Psychology Department's subject pool participated in the experiment. Mean age of participants was 19.8 and participant age ranged from 18 to 25. 88 of the 92 participants were native English speakers. The age at which the remaining four participants started learning English ranged from age 3 to 10.[6] As in Experiment 1, the sample size was set at 64, which doubled the number of participants in Fisher and Craik's study (1977, Exp. 2) to increase power. Data from the additional 28 participants were collected to obtain a final sample of 64 participants who could correctly explain the distinction between remembering and knowing. As in the first experiment, this exclusion criterion did not much change the results and will be discussed later. Participants were tested in groups of up to six and received either 1 course credit or $10 for their participation. The study was approved by Washington University's Institutional Review Board.

Materials and design

The materials and design of Experiment 2 was the same as Experiment 1, except for the test cues. Instead of a random presentation of cue words at test (e.g., *argue* or *kite*, for the target word *fight*), the test in Experiment 2 was a random presentation of cues whose nature was made clearer by stating whether they were associate cues or rhyme cues (e.g., *associated with argue* or *rhymes with kite,* for the target word *fight*). Specifically, cue words from Experiment 1 were presented either with the phrase *associated with* in front of those that are semantically related to target words, or with the phrase *rhymes with* in front of those that are phonetically related to target words (see Appendix A for a list of the target words with their respective associates and rhymes).

Procedure

The procedure of Experiment 2 was the same as Experiment 1. All participants in this experiment were given an outline of the experiment and were read the instructions regarding how to provide remember, know, and guess responses. One of the participants in each session was asked to repeat the distinction between remembering, knowing and guessing, to check whether participants understood the instructions before they began the experiment. The experiment lasted 34.6 min on average.

Scoring

Scoring was similar to Experiment 1. Only one rater scored the post-experimental questionnaire, because the two raters had shown good agreement in the first experiment. The participants who were given a score of 0 for their understanding of the distinction between remember, know and guess judgments were replaced until the set number of participants ($N = 64$) was obtained.

[5] Familiarity estimates of the full sample did not differ from the results reported here. See Appendix C for the table including individual means.

[6] The results did not change when non-native English speakers were excluded from our analyses, therefore the results reported in the main text include both native and non-native speakers of English.

Table 2
Descriptive statistics of proportions across conditions in Experiment 2.

	RR	RA	AR	AA
Recall	.49 *(.20)*	.49 *(.19)*	.23 *(.18)*	.91 *(.10)*
Remember	.29 *(.22)*	.10 *(.17)*	.07 *(.14)*	.71 *(.22)*
Know	.11 *(.11)*	.14 *(.13)*	.07 *(.09)*	.15 *(.13)*
Familiarity	.17 *(.15)*	.16 *(.15)*	.08 *(.10)*	.51 *(.35)*

Note. Standard deviations are reported in parentheses. RR: Rhyme study-Rhyme test; RA: Rhyme study-Associate test; AR: Associate study-Rhyme test; AA: Associate study-Associate test. The remember and know proportions are calculated by diving the number of responses in a condition by the total number of items in that condition. Familiarity is calculated with the remember and know proportions using the IRK procedure (K/(1-R)).

Results and discussion

As noted above, participants with a score of 0 on the post-experimental question regarding the distinction between remember, know and guess responses were replaced until a sample of 64 participants with a score of 1 was obtained. As in Experiment 1, this exclusion of participants did not change the results and is discussed later. The results reported below are based on 64 participants who were able to correctly explain the distinction between remember, know and guess responses in the post-experimental questionnaire. Table 2 contains the descriptive statistics across the four conditions. The overall accuracy for answering the orienting questions in the study phase was 98%. All omnibus tests of statistical significance used an alpha level of .05 and corresponding means are reported with 95% confidence intervals. Because many of the critical comparisons required post hoc tests to determine the nature of interactions, an alpha level of .001 was used for these comparisons and corresponding means are reported with 99.9% confidence intervals. Effect sizes are reported using partial eta-squared (η_p^2) for main effects and interactions, and Cohen's *d* for pairwise comparisons.

Recall

The proportion of words correctly recalled was calculated for each of the four within-subjects conditions: associate at study-associate cue at test (AA), associate at study-rhyme cue at test (AR), rhyme at study-associate cue at test (RA), rhyme at study-rhyme cue at test (RR). Fig. 4 shows proportion recalled in each condition. Similar to the first experiment, answering associate orienting questions during study led to greater recall ($M = 0.57$, [0.54, 0.60]) compared to answering rhyme orienting questions ($M = 0.49$, [0.45, 0.52]), $F(1, 63) = 39.50$, $\eta_p^2 = 0.39$. In addition, recalling with associate cues increased recall ($M = 0.70$, [0.67, 0.73]) compared to recalling with rhyme cues ($M = 0.36$, [0.32, 0.40]), $F(1, 63) = 448.41$, $\eta_p^2 = 0.88$. The interaction between orienting question and test cue was also significant, $F(1, 63) = 193.06$, $\eta_p^2 = 0.75$. Similar to the first experiment, participants recalled more in the AA condition compared to both the RA and the AR conditions ($t(63) = 16.10$, $d = 2.74$ and $t(63) = 26.52$, $d = 4.63$, respectively). Participants recalled more in the RR condition compared to the AR condition ($t(63) = 8.73$, $d = 1.36$), but not compared to the RA condition ($d = 0$).[7]

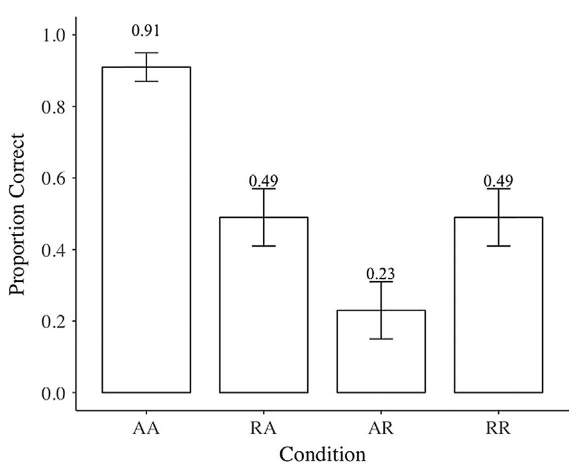

Fig. 4. Recall across the different conditions in Experiment 2. AA: Associate study-Associate test; RA: Rhyme study-Associate test; AR: Associate study-Rhyme test; RR: Rhyme study-Rhyme test. Error bars represent 99.9% confidence intervals.

The pattern of recall results was similar to the results of Experiment 1, although overall recall in this experiment was higher. In addition, recall in the AR condition was not as low as the previous experiment, suggesting that changing the test cues helped the participants. However, in both experiments, we failed to completely replicate Fisher and Craik's (1977, Exp. 2) recall results. Although recall in the AA condition was higher than both the AR and RA conditions, recall in the RR condition was only higher than the AR condition and was equivalent to the RA condition. Thus, the cue-target congruency effect held when rhyme cues were used in the two encoding conditions (RR > AR), but powerful semantic cues led to equivalent recall with rhyme encoding (RR = RA). We assume that even when the orienting task encourages phonetic processing, participants are able to extract meaning from the word, too (Postman & Kruesi, 1977)

Remember and know responses

Proportions of remember and know responses were calculated as in Experiment 1. Fig. 5 shows the proportion of remember and know responses across conditions. Remember responses were similar to those in the first experiment. Answering associate orienting questions during study led to more remembering at test ($M = 0.39$, [0.35, 0.42]), compared to answering rhyme orienting questions ($M = 0.19$, [0.15, 0.24]), $F(1, 63) = 190.98$, $\eta_p^2 = 0.75$. Recalling with associate cues also led to more remembering at test ($M = 0.40$, [0.36, 0.44]) compared to recalling with rhyme cues ($M = 0.18$, [0.14, 0.22]), $F(1, 63) = 287.30$, $\eta_p^2 = 0.82$. Again, the interaction between orienting question and test cue was also significant, $F(1, 63) = 280.53$, $\eta_p^2 = 0.82$. Participants gave more remember responses in the AA condition compared to the RA and AR conditions ($t(63) = 19.95$, $d = 3.08$ and $t(63) = 21.05$, $d = 3.44$, respectively). Participants also gave more remember responses in the RR condition compared to the AR and RA conditions ($t(63) = 8.29$, $d = 1.18$ and $t(63) = 7.33$, $d = 0.96$, respectively). These results replicate those of the first experiment and further support the prediction that the increased recall when encoding and retrieval conditions match is driven by increased remembering. Furthermore, although we failed to replicate one aspect of Fisher and Craik' (1977) results with our recall results (the superiority of RR to RA recall), we replicated their pattern of results in remember responses.

Similar to the first experiment, know responses did not differ based on which orienting question participants answered during study, but test cue significantly affected knowing, $F(1, 63) = 22.61$, $\eta_p^2 = 0.26$. Participants gave more know responses when they recalled with associate cues ($M = 0.15$, [0.12, 0.17]) compared to when they recalled with rhyme cues ($M = 0.09$, [0.07, 0.11]). Unlike Experiment 1, the interaction between orienting question and test cue was not significant.[8] An analysis of guess responses can be found in Appendix E.

[7] Recall results of the full sample did not differ from the results reported here. See Appendix D for the table including individual means.

[8] Results based on the proportion of remember responses of the full sample did not differ from the results reported here. The only difference was in the proportion of know responses. The interaction between orienting question and test cue was significant, $F(1, 91) = 10.42$, $\eta_p^2 = .10$. Knowing in the AR condition was lower than that in the other conditions (all *t*s > 3.5). See Appendix D for the tables including individual means.

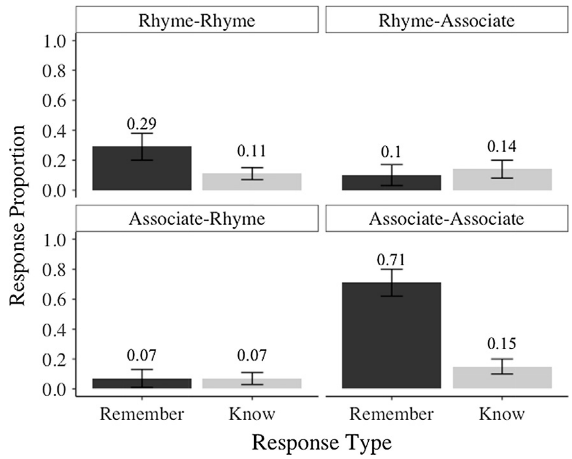

Fig. 5. Proportions of remember and know responses across the different conditions in Experiment 2. Error bars represent 99.9% confidence intervals.

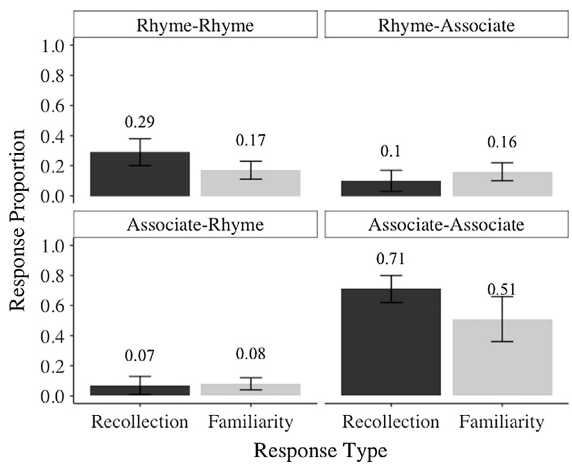

Fig. 6. Estimates of recollection and familiarity across the different conditions in Experiment 2 using the Independence Remember/Know (IRK) procedure. Error bars represent 99.9% confidence intervals.

As in the previous experiment, an estimate of familiarity was calculated for each condition using the IRK procedure, and the results largely replicated those of Experiment 1. Fig. 6 shows the estimates of recollection (i.e., the proportion of remember responses) and familiarity across the different conditions. Answering associate orienting questions during study increased the estimates of familiarity at test ($M = 0.29$, [0.24, 0.34]), compared to when answering rhyme orienting questions ($M = 0.17$, [0.14, 0.19]), $F(1, 63) = 25.59$, $\eta_p^2 = 0.29$. Familiarity was also higher when recalling with associate cues ($M = 0.33$, [0.28, 0.39]) compared to recalling with rhyme cues ($M = 0.12$, [0.10, 0.14]), $F(1, 63) = 70.76$, $\eta_p^2 = 0.53$. The interaction between orienting question and test cue was significant as well, $F(1, 63) = 82.34$, $\eta_p^2 = 0.57$. As in the first experiment, familiarity in the AA condition was greater than in the RA and AR conditions ($t(63) = 7.90$, $d = 1.29$ and $t(63) = 10.51$, $d = 1.66$, respectively). Familiarity in the RR condition was greater compared to the AR condition ($t(63) = 4.13$, $d = 0.70$), but not compared to the RA condition ($d = 0.07$).[9] Based on these results, familiarity as well as recollection accompanies the increased recall when encoding and retrieval conditions match.

[9] Familiarity estimates of the full sample did not differ from the results reported here. See Appendix D for the table including individual means.

General discussion

The principal aim of this study was to investigate whether the increased recall caused by reinstating encoding conditions during retrieval is accompanied by increased remembering, knowing, or both. We used the remember/know paradigm in cued recall experiments where we manipulated semantic and rhyme contexts. In both experiments, recall was generally greater when the test cues matched study conditions, but the lack of superior recall in the RR condition compared to the RA condition resulted in a failure to replicate one aspect of Fisher and Craik's results (1977). However, using remember responses as a measure of episodic recollection, the interaction between encoding and retrieval was more pronounced and, in a sense, replicated the results of Fisher and Craik (1977). In addition, when examining what retrieval experience was responsible for this increase, results revealed that the increased recall when encoding and retrieval conditions match was in general accompanied both by enhanced recollection (measured by remember responses) and familiarity (measured by know responses transformed with the IRK procedure).

A major distinction between our experiments and Fisher and Craik's (1977) was the materials used, which may explain the slight difference in our recall results. In Fisher and Craik's second experiment, the difference between recalling with associate cues and recalling with rhyme cues (calculated by subtracting the marginal means) was equivalent to the difference between studying with associate cues and studying with rhyme cues. In our experiments, however, the effect size reflecting the superiority of associate cues over rhyme cues was greater at test than at study. This finding indicates that the associate cues in our experiments were more powerful and may have led participants to generate the correct answer simply by guessing. This is further supported by the finding in both of the experiments that the largest proportion of accurate guess responses was given in the RA condition (see Appendix E). If less powerful associate cues were used at test, recall in the RA condition may have been lower, resulting in a replication of Fisher and Craik's (1977, Exp. 2) results.

The way in which target words were presented in our study phase also differed from Fisher and Craik's (1977, Exp. 2) procedure. They presented a cue word above each target word to provide context. In our experiments, however, participants were provided with cues within orienting questions, and they responded to the target words by indicating whether they rhymed with or were associated to the cue words in the orienting questions. We made this change to ensure participants were paying attention to the target words and the relation of the target word to the cue word in the study phase. Although we do not think this change would result in a failure to exactly replicate the pattern of recall results Fisher and Craik (1977) reported, it may have affected the way in which targets and cues were encoded.

Fisher and Craik (1977)'s study is highly-cited, but to our knowledge it has not been directly replicated. Our results are largely similar to theirs, but whether our failure to exactly replicate their results in Experiment 2 is due to the materials we used or for other reasons requires more research. However, we did replicate Fisher and Craik's (1977, Exp. 2) recall results using remember responses as a measure of episodic recollection, suggesting that encoding/retrieval interactions may primarily be driven by recollection.

In both experiments, remember and know results were similar despite the differences in the level of recall and whether we instructed participants on the type of cue at test. Accurate remember responses generally mimicked overall accurate responding. Participants remembered a word more often when they had studied it with an associate orienting question than a rhyme orienting question, replicating previous research showing that deeper levels of processing lead to more remember responses (Gardiner, 1988). Participants also provided more remember responses when they recalled with an associate cue compared to a rhyme cue. As predicted, participants gave significantly more remember responses when encoding and retrieval conditions matched

(AA and RR conditions) compared to when they did not (AR and RA conditions). The proportion of know responses showed a significant interaction between orienting questions and test cues in the first experiment; however, this effect disappeared in the second experiment.

The high rate of guessing in the RA condition in both experiments is striking, even though the rates of guessing were not of theoretical interest. Participants correctly guessed 19.5% of all target words in this condition (on average, across the two experiments), whereas they guessed 5.2% in the other conditions. This finding is in line with earlier research discussing the power of extra-list associative cues in promoting accurate recall (Bahrick, 1969; Tulving & Thomson, 1973). Retrieval cues in our mismatch conditions (AR and RA) can be considered extra-list cues. The high rate of guessing in the RA condition suggests that the provision of extra-list associate cues during retrieval led to correct recall even when participants studied those words with rhyme cues. However, the rate of guessing was not as high in the AR condition. Associate cues might be better able to isolate target words among candidates (they offer more distinctiveness), whereas rhyme cues may not be as effective in providing distinctiveness (Goh & Lu, 2012; Nairne, 2002). For instance, the target word *gold* could be studied with *mold* and tested with *silver* in the RA condition. The cue *silver* (especially when the nature of the cue is specified as in Experiment 2) can easily remind the word *gold*, and participants might then realize that *gold* was in fact a word they studied. On the other hand, *gold* could be studied with *silver*, but then tested with *mold* in the AR condition. As there were more than one rhymes for each target word, a rhyme cue may not have been helpful in isolating the target word. Therefore, participants may not have correctly guessed the target word with a rhyme cue as they did with an associate cue.

We only reported absolute (or raw) measures of remembering and knowing, but a different way to report remember and know results is to use relative (or conditional) proportions. These are calculated by dividing the number of a response type in a condition to the number of correctly recalled items in that particular condition. This way, remembering and knowing across conditions can be compared on the same scale ranging from zero to one, instead of being bound by the recall level in corresponding conditions. The analysis of remember responses using these proportions yield the same results reported above for both experiments; remembering in the match conditions is higher than remembering in the mismatch conditions. However, the analysis of know responses differ from the results reported above for both experiments, such that there is almost no difference in the proportion of knowing across conditions. Because we do not consider remembering and knowing as mutually exclusive, the know responses transformed using the IRK procedure (Jacoby et al., 1997) likely give us a better estimate of familiarity.

We used the IRK procedure developed by Jacoby et al. (1997) under the assumption that remember and know responses are independent of one another to estimate the contribution of familiarity in recall performance. In both experiments, estimates of familiarity showed a similar pattern to accurate recall in which there was a large difference between the AA and AR conditions but no difference between the RA and RR conditions. Although more recollection typically contributed to recall, familiarity seems to contribute to the encoding/retrieval interactions in recall as well.

Rajaram's (1996, 1998) distinctiveness/fluency framework provides a viable account to explain our results. Within this framework, distinctive or salient processing of events during study are associated with increased remembering, and fluency or ease of processing of events at test is associated with increased knowing. It is likely that distinctive processing was induced in our experiments when participants were asked to relate a target word to the cue word within the corresponding orienting question. Receiving the same cue from study at test may have reminded participants of their distinctive processing of targets, resulting in increased remembering. On the other hand, because participants were always given cue words they had seen in the study phase in the match conditions (AA and RR), and they were always given novel cue words in the mismatch conditions (RA and AR), this may have increased fluency of processing in the match conditions and may explain any increase in knowing or familiarity in our experiments. Although Fisher and Craik later addressed this confound (Exp. 3, 1977) and still showed an interaction between encoding and retrieval even when all test cues were novel, whether this would change the extent to which remembering and knowing are responsible awaits future research.

In our experiments, we used the remember/know paradigm in cued recall. Although the first study to use the remember/know procedure used free recall, cued recall and recognition (Tulving, 1985), the procedure has been used mostly in recognition memory experiments since then. Yet, some research investigated remembering and knowing in recall tasks (e.g., Hamilton & Rajaram, 2003; Lindsay & Kelley, 1996; McCabe et al., 2011; McDermott, 2006; Mickes et al., 2013). These studies have shown that, even though recall tasks are associated with recollection, familiarity is also involved in these tasks (Mickes et al., 2013). This is further supported by our data. Although remembering was the most commonly reported retrieval experience and contributed to 56% of accurate recall responses on average across the two experiments, knowing contributed to 22% of all accurate recall responses, suggesting that both remembering and knowing lead to correct recall.

The remember/know paradigm has been criticized regarding its interpretation of remember and know judgments. One major criticism is whether these judgments are simply a proxy of confidence and measure memory strength (Donaldson, 1996; Dunn, 2004). Single process theorists assume that remember and know judgments do not tap into separate processes (such as recollection and familiarity, as we have assumed in our paper), but that they reflect responding based on different adopted criteria on a single continuum of memory signal or strength (Donaldson, 1996; Dunn, 2004). This theory assumes the signal detection model in which remember and know judgments reflect different levels of confidence. The stronger the memory trace is, the more confident participants will be, and they will provide a remember response. On the other hand, if the memory trace is weaker, participants will be less confident and therefore give a know response (Donaldson, 1996). If this unidimensional account is true, it would suggest that participants in our study were more confident when the encoding context was reinstated at retrieval (i.e., AA and RR conditions).

Although the single process model can account for many findings in the existing literature (Dunn, 2004), some studies have shown that remember and know judgments do not directly map onto high versus low confidence responses (e.g., Gardiner & Java, 1990; Rajaram, Hamilton, & Bolton, 2002). In addition, Mickes, et al. (2013), using free recall and obtaining confidence ratings for both remember and know responses, showed that high confidence know responses were more accurate than low confidence remember responses, contrary to the idea that remember and know responses just measure different levels of confidence on a single continuum. Our experiments did not use confidence judgments, and thus cannot provide a similar test. However, the instructions regarding remembering, knowing and guessing used in both our experiments suggested that remembering and knowing are not high and low confidence judgments, respectively. Know responses were defined as cases in which participants recall a word confidently without having any recollective experience. In fact, the participants who explained the distinction between remembering and knowing based on different levels of confidence were replaced. 19 of the 75 participants that were replaced were such cases, suggesting that these responses may be tied to confidence. However, since the main analyses across both experiments exclude these participants, we do not believe the single process theory can account for our findings.

In the current study, we used the remember/know paradigm to infer the underlying processes of recollection and familiarity. The remember/know paradigm is intended to measure subjective experience by having participants categorize their responses into a remember or know response. This mutual exclusivity assumed in the procedure does not readily map onto the assumption that recollection and familiarity can have independent contributions during retrieval. Although we used Jacoby et al.'s IRK procedure to obtain familiarity estimates independent of recollection, transforming participants' subjective experiences may no longer reflect what the remember/know paradigm is intended to assess. However, other methods exist to measure the contributions of recollection and familiarity. For instance, researchers have asked participants to independently rate recollection and familiarity for each retrieved item during test (Brown & Bodner, 2011; Higham & Vokey, 2004; Ingram, Mickes, & Wixted, 2012) instead of categorizing each retrieved item as remembered or known. The independent rating method does not assume mutual exclusivity between recollection and familiarity; therefore, it may result in more accurate estimates of these processes. Recollection and familiarity can also be measured through tasks that do not require using the remember/know paradigm, such as Jacoby's (1991) process-dissociation procedure. Even though this procedure is different from the remember/know paradigm, McCabe et al. (2011) showed similar results when familiarity was calculated through the process-dissociation procedure and the IRK procedure.

In both experiments, a post-experimental questionnaire was used to identify the participants who did not understand the remember, know, and guess instructions correctly. To our surprise, although participants were given both written and verbal instructions and one participant in each group was asked to explain the instructions to the experimenter, 37% of all the participants in the current study did not correctly explain the distinction on the post-experimental questionnaire. Geraci, McCabe and Guillory (2009) noted that, based on their post-test questionnaire, about 20% of their participants did not understand their instructions. We used a conservative criterion and excluded these participants from the main analyses. Any differences in the results when all participants are included in the analyses are reported in the footnotes, but the results including all participants were similar to the results based only on those whose responses indicated that they understood the distinction. This lack of a difference suggests that participants may be using each response as instructed during the experiment, but that the distinction between remembering, knowing and guessing may not be easily verbalizable.

Prior researchers have noted the difficulty of using the remember/know procedure. Regarding remember/know studies, Migo, Mayes, and Montaldi (2012) stated that "the methods should matter as much as the theory" (p. 1451). Similarly, Geraci et al. (2009) noted the great variability in the remember/know instructions provided across labs. According to Geraci et al., some researchers instruct participants to provide a remember response when they can remember contextual details and to provide a know response when they cannot. Some instructions relate know responses to a sense of familiarity, and other instructions associate them with high confidence in the absence of contextual details. In two experiments, Geraci et al. (2009) showed that simply using different instructions (i.e., whether remembering and knowing are related to high confidence or whether only remembering is related to high confidence) can change the degree of remembering and knowing that participants report. Because the use of remembering and knowing in everyday life does not exactly map onto their meaning within the remember/know procedure, participants are typically given extensive instructions on how to provide these responses. For instance, they are often given written and verbal instructions, and are also asked to explain what the distinction is before they begin making these judgements. In some cases, researchers pick a few of each participants' responses and ask them to explain why they remembered or knew that particular response (e.g., Gardiner, Richardson-Klavehn, & Ramponi, 1997). In order to avoid confusions, McCabe and Geraci (2009) used the terms Type A memory and Type B memory to refer to remembering and knowing, and they showed that participants made fewer remember false alarms and therefore had higher overall accuracy when remembering and knowing were introduced as neutral terms. Although these kinds of control are necessary, from our study it appears that participants can use remember, know, and guess responses in a sensible way even when they cannot accurately explain the distinctions. In both experiments, we arrived at similar conclusions when including or excluding those participants who could not explain the distinction between remembering, knowing and guessing correctly.

Conclusion

We asked whether improved recall when encoding and retrieval conditions match is driven by experiences of remembering, of knowing or of both. In both experiments, recall was enhanced by matching encoding and retrieval conditions using semantic and phonetic cues, in line with the principles of encoding specificity or transfer appropriate processing. Using Tulving's (1985) framework, we showed that this enhanced recall was primarily driven by remembering and by some knowing. Using Jacoby et al.'s (1997) framework, we showed that both recollection and familiarity played a role in the enhanced recall. Our findings suggest that two different processes drive successful retrieval with powerful cues.

Acknowledgments

This work was part of a master's thesis of the first author under the supervision of the second author. We thank Kathleen McDermott and Andrew Butler for their helpful comments as part of the committee. We would also like to thank Dave Balota for his input on this research. We also thank Eylul Tekin and Francis Anderson for helpful discussions and comments on this manuscript. In addition, we would like to thank Carli Ryan, Adam Wachsman and Carolina D'Andrea for their help in putting together materials, data collection and scoring.

Conflict of interest

None.

Funding

This work was supported by a Collaborative Activity Award from the James S. McDonnell Foundation.

Appendix A

Materials

TARGET	ASSOCIATE	RHYME	UNRELATED
ALONE	ISOLATED	STONE	POOL
ANSWER	QUESTION	DANCER	THIEF
ARMOR	KNIGHT	FARMER	TIME
BACK	FRONT	RACK	ROSE
BALL	BOUNCE	WALL	LIGHT
BEACH	SAND	PEACH	CHURCH

BELT	BUCKLE	MELT	MOVIE
BIRD	PARROT	WORD	JUDGE
BLOOD	DONOR	FLOOD	PHONE
BOAT	SAIL	VOTE	DEER
BOOK	PAGE	COOK	PURSE
BRUSH	COMB	FLUSH	SPEED
CHAIR	TABLE	BEAR	SALAD
CHILD	ADULT	WILD	EXIT
CHOICE	OPTION	VOICE	LION
CITY	TOWN	PITY	POTATO
CLOSE	SHUT	DOSE	JUICE
COUCH	SOFA	CROUCH	RING
DEATH	FUNERAL	BREATH	SOAP
DEVIL	DEMON	LEVEL	SLEEVE
DIRTY	CLEAN	THIRTY	ZIPPER
DREAM	FANTASY	CREAM	COIN
DRUNK	SOBER	TRUNK	QUEEN
EARTH	PLANET	WORTH	WIFE
EGGS	BACON	LEGS	DRAWER
FAST	QUICK	PAST	CHEESE
FIGHT	ARGUE	KITE	NOVEL
FIND	SEEK	KIND	PALE
FLOWER	BLOOM	HOUR	TOOL
FOREVER	INFINITY	CLEVER	GLOVE
FORGET	FORGIVE	SWEAT	NOUN
FORK	SPOON	CORK	ARTICLE
FRIEND	BUDDY	ATTEND	TUBE
GHOST	PHANTOM	POST	SOCK
GIVE	TAKE	LIVE	MOUSE
GOLD	SILVER	MOLD	STREET
GRAPE	VINE	SHAPE	SHUTTLE
GRASS	WEED	BRASS	DEBATE
GUESS	ESTIMATE	LESS	NAVY
HAMMER	NAIL	GRAMMAR	SPICE
HARD	SOFT	YARD	COFFEE
HATE	DISLIKE	WEIGHT	SPINE
HORSE	PONY	SOURCE	CHALK
IDEA	CONCEPT	DIARRHEA	BEARD
JAIL	PRISON	TAIL	JACKET
KING	CROWN	WING	SAUCE
LAUGH	JOKE	GRAPH	BONE
LETTER	ENVELOPE	BETTER	NURSE
MATH	EQUATION	BATH	DRUG
MIDDLE	CENTER	RIDDLE	DOOR
MILK	DAIRY	SILK	EXPLODE
MONEY	BANK	HONEY	OCEAN
MOUNTAIN	HILL	FOUNTAIN	MUSTARD
PAIN	HURT	LANE	SPEND
PLACE	LOCATION	GRACE	BUTLER
POLICE	OFFICER	RELEASE	NEAT
PRESENT	GIFT	PEASANT	ORANGE
PUSH	SHOVE	BUSH	DIAMOND
RABBIT	HARE	HABIT	PERFUME
RICH	POOR	WITCH	BAND
SAME	SIMILAR	FAME	PENCIL
SHIRT	BLOUSE	ALERT	CLIMB
SHORT	TALL	COURT	SEARCH
SICK	ILLNESS	BRICK	DOZEN
SLEEP	TIRED	CHEAP	DOLPHIN
SLOW	SNAIL	BLOW	SOIL
SMART	WISE	CART	FRAME
SMELL	ODOR	BELL	ALTER
SMOKE	CIGARETTE	CLOAK	CAKE
SNAKE	SERPENT	LAKE	BUTTER
SONG	MELODY	WRONG	DOCTOR
SWEET	SUGAR	RECEIPT	ROCK

TALK	SPEAK	WALK	WINNER
TEACHER	INSTRUCTOR	FEATURE	LUNCH
TEST	EXAM	WEST	LORD
TREE	FOREST	KNEE	RECALL
TRIP	JOURNEY	GRIP	CLOCK
UNDER	OVER	WONDER	FIRST
WAITER	SERVER	SKATER	LOVE
WORK	LABOR	JERK	FISH

Appendix B

Instructions

In the study phase, you will answer YES/NO questions about target words. Each question is followed by a target word presented in the middle of the screen in capital letters. Pay close attention to each question and make sure your answer is correct. You will take a test on the target words presented in capital letters, so try to learn each word in addition to making the YES/NO response.

In the test phase, you will see a cue on the screen. Your task is to type in a target word from the study phase that the cue reminds you. You should then click SUBMIT. After you submit your response, you will see a screen with four buttons. These buttons will be REMEMBER, KNOW, GUESS, and NO RECALL, respectively. You should select one of these buttons that describes your recall response the best. Here is how we want you to distinguish between these judgments.

Memory is associated with two different kinds of awareness. Often, recall brings back to mind something you recollect about what it is that you recall. For example, you recognize a face, and remember talking to this person at a party the previous night. At other times recall brings nothing back to mind about what it is you recall. For example, you are confident that you recognize someone, and you know you recognize them, because of strong feelings of familiarity, but you have no recollection of seeing this person before. You do not remember anything about them.

The same kinds of awareness are associated with recalling the words you will see during the study phase. Sometimes when you recall a word, this will bring back to mind something you remember thinking about when the word appeared in the study phase. You will recollect something you consciously experienced at that time. But sometimes recalling a word won't bring back to mind anything you remember about seeing it in the study phase. Instead, the word will seem familiar, you'll feel confident it was one you saw in the experiment, even though you won't recollect anything you experienced when you saw it in the study phase. For each word that you recall, please then click the REMEMBER button if recall is accompanied by some recollective experience, or the KNOW button if recall is accompanied by strong feelings of familiarity in the absence of any recollective experience.

If the word you recall triggers something you experienced when you saw it in the study phase, for example, something about its appearance on the screen, or the order in which the word came in, please indicate this kind of recall by clicking the REMEMBER button. The word you recall may also remind you of something you thought about when you saw it in the study phase, for example, an association you made to the word, the question the word was paired with, an image you formed when you saw the word, or something of personal significance that you associated with the word. If you can recollect any of these aspects when you recall the word, please click the REMEMBER button.

Instead, at other times, you will recall a word, but the word will not bring back to mind anything you remember about seeing it in the study phase, the word will just seem extremely familiar. When you feel confident that you saw the word in the study phase, even though you do not recollect anything you experienced when you saw it, please indicate this kind of recall by clicking the KNOW button.

There will also be times when you won't remember the word, nor will it seem familiar, but you might want to guess that it was one of the words you saw in the study phase. Feel free to do this, but if your recall response is really just a guess, please then click the GUESS button. With a guess response, you think it possible that the word was presented but you are not sure that it was. For example, some people say that the word looks like a word that could have possibly been there. When you think your response is really just a guess, please click the GUESS button.

Finally, if you are unable to recall the target word, please click the NO RECALL button in the following screen. In other words, you should click NO RECALL if you were not able to type in a response in the immediately preceding trial.

Appendix C

Additional results from Experiment 1

See Table 3.

Table 3
Recall, remember and know proportions, and estimates of familiarity in Experiment 1 for the full sample (N = 108).

	RR	RA	AR	AA
Recall	.32 *(.21)*	.37 *(.24)*	.06 *(.08)*	.88 *(.12)*
Remember	.19 *(.17)*	.07 *(.12)*	.01 *(.02)*	.65 *(.25)*
Know	.09 *(.11)*	.07 *(.10)*	.01 *(.04)*	.19 *(.20)*
Familiarity	.12 *(.14)*	.09 *(.13)*	.01 *(.04)*	.48 *(.34)*

Note. Standard deviations are reported in parentheses. RR: Rhyme study-Rhyme test; RA: Rhyme study-Associate test; AR: Associate study-Rhyme test; AA: Associate study-Associate test. Familiarity refers to the know proportions transformed with the IRK procedure.

Appendix D

Additional results from Experiment 2

See Table 4.

Table 4
Recall, remember and know proportions, and estimates of familiarity in Experiment 2 for the full sample (N = 92).

	RR	RA	AR	AA
Recall	.47 *(.20)*	.47 *(.20)*	.21 *(.17)*	.90 *(.12)*
Remember	.28 *(.22)*	.08 *(.15)*	.06 *(.12)*	.67 *(.25)*
Know	.11 *(.10)*	.12 *(.13)*	.06 *(.08)*	.16 *(.15)*
Familiarity	.16 *(.14)*	.14 *(.15)*	.06 *(.09)*	.46 *(.35)*

Note. Standard deviations are reported in parentheses. RR: Rhyme study-Rhyme test; RA: Rhyme study-Associate test; AR: Associate study-Rhyme test; AA: Associate study-Associate test. Familiarity refers to the know proportions transformed with the IRK procedure.

Appendix E

Guess results from Experiments 1 and 2

Proportion of guess responses showed a similar pattern in both experiments. Participants guessed more when they studied words with rhyme cues ($M = 0.11$, [0.08, 0.13] and $M = 0.15$, [0.13, 0.18]) compared to associate cues ($M = 0.03$, [0.02, 0.04] and $M = 0.07$, [0.05, 0.08]), $F(1, 61) = 51.17$, $\eta_p^2 = 0.46$ and $F(1, 63) = 61.94$, $\eta_p^2 = 0.50$ (in Experiments 1 and 2, respectively). Participants also guessed more when they were tested with associate cues ($M = 0.11$, [0.08, 0.13] and $M = 0.14$, [0.12, 0.16]) compared to rhyme cues ($M = 0.03$, [0.02, 0.03] and $M = 0.08$, [0.07, 0.10]), $F(1, 61) = 41.91$, $\eta_p^2 = 0.41$ and $F(1, 63) = 22.48$, $\eta_p^2 = 0.26$ (in Experiments 1 and 2, respectively). The interaction between study and test cues was also significant, $F(1, 61) = 20.08$, $\eta_p^2 = 0.25$ and $F(1, 63) = 70.17$, $\eta_p^2 = 0.53$ (in Experiments 1 and 2, respectively). Participants in both experiments guessed more in the RA condition compared to the other conditions, all $ts > 5.97$. This outcome may be due to rhyme cues matching more words than semantic cues, leading to increased guessing (Nairne, 2002) (see Table 5).

Table 5
Descriptive statistics of guess rates across conditions in both experiments.

	RR	RA	AR	AA
Experiment 1	.04 *(.06)*	.17 *(.16)*	.02 *(.04)*	.04 *(.07)*
Experiment 2	.08 *(.09)*	.22 *(.13)*	.08 *(.09)*	.05 *(.08)*

Note. Standard deviations are reported in parentheses. RR: Rhyme study-Rhyme test; RA: Rhyme study-Associate test; AR: Associate study-Rhyme test; AA: Associate study-Associate test. The guess proportions are calculated by diving the number of guess responses in a condition by the total number of items in that condition.

References

Bahrick, H. P. (1969). Measurement of memory by prompted recall. *Journal of Experimental Psychology, 79*(2), 213–219.

Balota, D. A., Yap, M. J., Cortese, M. J., Hutchison, K. A., Kessler, B., Loftis, B., ... Treiman, R. (2007). The English Lexicon project. *Behavior Research Methods, 39*(3), 445–459.

Brown, A. A., & Bodner, G. E. (2011). Re-examining dissociations between remembering and knowing: Binary judgments vs. independent ratings. *Journal of Memory and Language, 65*(2), 98–108.

Craik, F. I. M., & Lockhart, R. S. (1972). Levels of processing: A framework for memory research. *Journal of Verbal Learning and Verbal Behavior, 11*(6), 671–684.

Craik, F. I. M., & Tulving, E. (1975). Depth of processing and the retention of words in episodic memory. *Journal of Experimental Psychology: General, 104*(3), 268–294.

Dewhurst, S. A., & Brandt, K. R. (2007). Reinstating effortful encoding operations at test enhances episodic remembering. *The Quarterly Journal of Experimental Psychology, 60*(4), 543–550.

Dewhurst, S. A., & Conway, M. A. (1994). Pictures, images, and recollective experience. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 20*(5), 1088–1098.

Donaldson, W. (1996). The role of decision processes in remembering and knowing. *Memory & Cognition, 24*(4), 523–533.

Dunn, J. C. (2004). Remember-know: A matter of confidence. *Psychological Review, 111*(2), 524–542.

Eldridge, L. L., Sarfatti, S., & Knowlton, B. J. (2002). The effect of testing procedure on remember-know judgments. *Psychonomic Bulletin & Review, 9*(1), 139–145.

Fisher, R. P., & Craik, F. I. (1977). Interaction between encoding and retrieval operations in cued recall. *Journal of Experimental Psychology: Human Learning and Memory, 3*(6), 701–711.

Gardiner, J. M. (1988). Functional aspects of recollective experience. *Memory & Cognition, 16*(4), 309–313.

Gardiner, J. M., & Java, R. I. (1990). Recollective experience in word and nonword recognition. *Memory & Cognition, 18*(1), 23–30.

Gardiner, J. M., Java, R. I., & Richardson-Klavehn, A. (1996). How level of processing really influences awareness in recognition memory. *Canadian Journal of Experimental Psychology, 50*(1), 114–122.

Gardiner, J. M., Ramponi, C., & Richardson-Klavehn, A. (1998). Experiences of remembering, knowing, and guessing. *Consciousness and Cognition, 7*(1), 1–26.

Gardiner, J. M., Richardson-Klavehn, A., & Ramponi, C. (1997). On reporting recollective experiences and "direct access to memory systems". *Psychological Science, 8*(5), 391–394.

Geraci, L., McCabe, D. P., & Guillory, J. J. (2009). On interpreting the relationship between remember–know judgments and confidence: The role of instructions. *Consciousness and Cognition, 18*(3), 701–709.

Goh, W. D., & Lu, S. H. (2012). Testing the myth of the encoding–retrieval match. *Memory & Cognition, 40*(1), 28–39.

Graf, P., & Mandler, G. (1984). Activation makes words more accessible, but not necessarily more retrievable. *Journal of Verbal Learning and Verbal Behavior, 23*(5), 553–568.

Gregg, V. H., & Gardiner, J. M. (1994). Recognition memory and awareness: A large effect of study-test modalities on "know" responses following a highly perceptual orienting task. *European Journal of Cognitive Psychology, 6*(2), 131–147.

Hamilton, M., & Rajaram, S. (2003). States of awareness across multiple memory tasks: Obtaining a "pure" measure of conscious recollection. *Acta Psychologica, 112*(1), 43–69.

Higham, P. A., & Vokey, J. R. (2004). Illusory recollection and dual-process models of recognition memory. *Quarterly Journal of Experimental Psychology Section A, 57*(4),

714–744.
Ingram, K. M., Mickes, L., & Wixted, J. T. (2012). Recollection can be weak and familiarity can be strong. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 38*(2), 325–339.
Jacoby, L. L. (1975). Physical features vs meaning: A difference in decay. *Memory & Cognition, 3*(3), 247–251.
Jacoby, L. L. (1983). Remembering the data: Analyzing interactive processes in reading. *Journal of Verbal Learning and Verbal Behavior, 22*(5), 485–508.
Jacoby, L. L. (1991). A process dissociation framework: Separating automatic from intentional uses of memory. *Journal of Memory and Language, 30*(5), 513–541.
Jacoby, L. L., Yonelinas, A. P., & Jennings, J. M. (1997). The relation between conscious and unconscious (automatic) influences: A declaration of independence. In E. Jonathan, D. Cohen, & W. Schooler (Eds.). *Scientific approaches to consciousness* (pp. 13–47). Hillsdale, NJ: Erlbaum.
Lindsay, D. S., & Kelley, C. M. (1996). Creating illusions of familiarity in a cued recall remember/know paradigm. *Journal of Memory and Language, 35*(2), 197–211.
Macken, W. J. (2002). Environmental context and recognition: The role of recollection and familiarity. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 28*(1), 153–161.
Mandler, G. (1980). Recognizing: The judgment of previous occurrence. *Psychological Review, 87*(3), 252–271.
McCabe, D. P., & Geraci, L. D. (2009). The influence of instructions and terminology on the accuracy of remember–know judgments. *Consciousness and Cognition, 18*(2), 401–413.
McCabe, D. P., Roediger, H. L., & Karpicke, J. D. (2011). Automatic processing influences free recall: Converging evidence from the process dissociation procedure and remember-know judgments. *Memory & Cognition, 39*(3), 389–402.
McDaniel, M. A., Friedman, A., & Bourne, L. E. (1978). Remembering the levels of information in words. *Memory & Cognition, 6*(2), 156–164.
McDermott, K. B. (2006). Paradoxical effects of testing: Repeated retrieval attempts enhance the likelihood of later accurate and false recall. *Memory & Cognition, 34*(2), 261–267.
Mickes, L., Seale-Carlisle, T. M., & Wixted, J. T. (2013). Rethinking familiarity: Remember/Know judgments in free recall. *Journal of Memory and Language, 68*(4), 333–349.
Migo, E. M., Mayes, A. R., & Montaldi, D. (2012). Measuring recollection and familiarity: Improving the remember/know procedure. *Consciousness and Cognition, 21*(3), 1435–1455.
Morris, C. D., Bransford, J. D., & Franks, J. J. (1977). Levels of processing versus transfer appropriate processing. *Journal of Verbal Learning and Verbal Behavior, 16*(5), 519–533.
Nairne, J. S. (2002). The myth of the encoding-retrieval match. *Memory, 10*(5–6), 389–395.
Nelson, D. L., McEvoy, C. L., & Schreiber, T. A. (1998). The University of South Florida word association, rhyme, and word fragment norms. <http://www.usf.edu/FreeAssociation/>.
Postman, L., & Kruesi, E. (1977). The influence of orienting tasks on the encoding and recall of words. *Journal of Verbal Learning and Verbal Behavior, 16*(3), 353–369.
Quamme, J. R., Yonelinas, A. P., Widaman, K. F., Kroll, N. E., & Sauvé, M. J. (2004). Recall and recognition in mild hypoxia: Using covariance structural modeling to test competing theories of explicit memory. *Neuropsychologia, 42*(5), 672–691.
Rajaram, S. (1993). Remembering and knowing: Two means of access to the personal past. *Memory & Cognition, 21*(1), 89–102.
Rajaram, S. (1996). Perceptual effects on remembering: Recollective processes in picture recognition memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 22*(2), 365–377.
Rajaram, S. (1998). Conceptual and perceptual effects on remembering: The role of salience/distinctiveness. *Psychonomic Bulletin & Review, 5*, 71–78.
Rajaram, S., Hamilton, M., & Bolton, A. (2002). Distinguishing states of awareness from confidence during retrieval: Evidence from amnesia. *Cognitive, Affective, & Behavioral Neuroscience, 2*(3), 227–235.
Roediger, H. L., Rajaram, S., & Geraci, L. (2007). Three forms of consciousness in retrieving memories. In P. D. Zelazo, M. Moscovitch, & E. Thompson (Eds.). *Cambridge handbook of consciousness* (pp. 251–287). New York: Cambridge University Press.
Roediger, H. L., Tekin, E., & Uner, O. (2017). Encoding-retrieval interactions. In J. W. Wixted, & J. H. Byrne (Eds.). *Cognitive psychology of memory. Learning and memory: A comprehensive reference* (pp. 5–26). (2nd ed. Vol. 2). Oxford: Academic Press.
Tulving, E. (1974). Cue-dependent forgetting. *American Scientist, 62*(1), 74–82.
Tulving, E. (1979). *Relation between encoding specificity and levels of processing. Levels of processing in human memory.* Hillsdale, NJ: Erlbaum405–428.
Tulving, E. (1983). *Elements of episodic memory.* New York: Oxford.
Tulving, E. (1985). Memory and consciousness. *Canadian Psychology, 26*(1), 1–12.
Tulving, E., & Thomson, D. M. (1973). Encoding specificity and retrieval processes in episodic memory. *Psychological Review, 80*(5), 352–373.
Watkins, M. J. (1975). Inhibition in recall with extralist “cues”. *Journal of Verbal Learning and Verbal Behavior, 14*(3), 294–303.
Yonelinas, A. P. (2002). The nature of recollection and familiarity: A review of 30 years of research. *Journal of Memory and Language, 46*(3), 441–517.
Yonelinas, A. P., & Jacoby, L. L. (2012). The process-dissociation approach two decades later: Convergence, boundary conditions, and new directions. *Memory & Cognition, 40*(5), 663–680.