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Inhibiting False Memories: Influences of Encoding and Intention

Edward Tucker Cokely

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INHIBITING FALSE MEMORIES:

INFLUENCES OF ENCODING AND INTENTION

By

EDWARD TUCKER COKELY

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The members of the Committee approve the thesis of Edward T. Cokely defended on November 21, 2003.

Colleen M. Kelley
Professor Directing Thesis

Rolf Zwaan
Committee Member

Ashby Plant
Committee Member

The Office of Graduate Studies has verified and approved the above named committee members.

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ABSTRACT

Recent research suggests that intentional forgetting can lead to increases in false recollection, while manipulations of unintentional forgetting may cause decreases in false recollection. Kimball and Bjork (2002) demonstrated that list method directed forgetting produces a significant increase in the occurrence of false memories in the DRM paradigm, while a part-set cueing manipulation caused false memories to be inhibited (see also Reysen & Nairne, 2002). In a series of two experiments these results were examined and extended. In contrast to earlier work, by matching the encoding modalities and encoding time, and limiting opportunities for rehearsal and output interference, both procedures produced a significant decrease in false and veridical recall. The results indicate that the production and inhibition of false memories is largely mediated by encoding dynamics, and is not solely a function of one's intentions. Furthermore, they suggest that directed forgetting and part-set cueing may result from the same mechanism.

Introduction

In recent years, the existence and dynamics of false memories have been of keen public interest and debate. These false memories often intersect with the issue of forgetting and memory repression, or, more broadly, retrieval inhibition: a state in which memory accessibility is impaired without causing a commensurate loss of memory availability (Bjork, Bjork, & Anderson, 1998). Several vivid examples of eyewitness memory errors and confabulations of abuse (Loftus, 1993; 1994) have demonstrated the destructive potential of these phenomena. Moreover, recent work by Kimball and Bjork (2002) suggests a potentially hazardous property of the interaction of intentional forgetting and false recollection. That is, Kimball and Bjork's research suggests that intentional forgetting causes significant increases in false recollection, while unintentional forgetting decreases false recollection. In this way, trying to forget memories may facilitate false recall.

Kimball and Bjork (2002) investigated the effect of retrieval inhibition caused by directed forgetting and part-set cueing on false memories. False memory creation was accomplished using the Deese-Roediger-McDermott (DRM) paradigm, in which high semantic associates of non-presented words are studied and used to lure participants toward false recall of the item that was not presented. Kimball and Bjork as well as Seamon, Luo, Shulman, Toner, and Caglar (2002), found that directed forgetting instructions, which reliably result in a goal-congruent impaired access to memories, significantly increased rates of false recollection. In contrast, the impairment seen in part-set cueing, a procedure that paradoxically causes inhibition by providing some list items as memory cues, caused a reliable decrease in the frequency of false memories (Kimball & Bjork; Reysen & Nairne, 2002). Accordingly, Kimball and Bjork note that in addition to clinical and social ramifications their findings are theoretically important. That is, the dissociation of false recall in intentional and unintentional forgetting procedures suggests that directed forgetting and part-set cueing may result from different inhibitory mechanisms.

In response, this thesis will take a critical look at other factors that may influence the dynamics of false recollection. Specifically, I will examine how forces other than inhibition, such as the quality of encoding, may account for the dissociation observed by Seamon et al. (2002) and Kimball and Bjork (2002). Moreover, I will examine evidence consistent with the interpretation that these types of intentional and unintentional forgetting procedures rely on the same inhibitory mechanism (Basden & Basden, 1998; Basden, Basden, & Galloway, 1977).

False Memories: Deese-Roediger-McDermott

Roediger and McDermott (1995) developed materials based on research by Deese (1959; as cited in Roediger & McDermott) that consistently create false memories in the laboratory. The materials are designed such that semantic associates of a central theme word (termed the critical lure) are presented for study without presenting the critical lure word itself. For example, a participant might study strong semantic associates of the critical lure "slow" including fast, lethargic, stop, listless, snail… When these strong associates are presented in the absence of the critical lure participants reliably experience false recall and recognition of the word that was not presented: a false memory. The false memory is often accompanied by vivid details of its presentation and may be recalled or recognized more frequently than words that were actually presented (Payne, Elie, Blackwell, & Neuschatz, 1996).

The leading theoretical interpretations of the DRM false memory effects include the activation/monitoring hypotheses (Roediger & McDermott, 1995) and the fuzzy trace (Brainerd & Reyna, 1998) theory. The activation/monitoring hypothesis suggests that two processes, activation at encoding and failures of retrieval monitoring, drive false recollection. That is, the presentation of the strong semantic associates increases memory activation of the critical lure via a type of spreading activation based on associative strength as measured in free association (Gallo & Roediger, 2002) semantic and, or, contextual overlap. A second factor, ineffective monitoring of source memory detail (Gallo, McDermott, Percer, & Roediger, 2001), then allows the highly activated critical lure to be mistakenly recalled as a list item. Fuzzy trace theory, in contrast, posits that encoding initially creates two representations upon which later memory judgments can be based: a gist and a verbatim record. Over time, the verbatim record fades forcing memory judgments to increasingly rely on the gist record. Because the DRM lists are semantically related, the use of the gist record leads to an interpretation that the critical lure was on the list, and thus leads to the recall of the critical lure.

Retrieval Inhibition

In recent years, retrieval inhibition has received extensive attention, analysis, and experimental validation. As defined by Bjork, Bjork, and Anderson (1998), retrieval inhibition occurs when memory access is impaired without causing a commensurate loss of memory availability. This temporary memory impairment is the inability to intentionally retrieve the memories that are otherwise available to influence behavior, and has been demonstrated in a variety of procedures (Basden & Basden, 1998; Bjork, Bjork, & Anderson, 1998; McGeoch, 1936; Tulving & Pearlstone, 1966; Tulving & Psatka, 1971). More specifically, as noted by Kimball and Bjork (2002), retrieval inhibition broadly refers to any number of theoretical mechanisms that cause retrieval impairments. For example, memory suppression, repression, blocking, and cue-bias are all cases of retrieval inhibition (Anderson & Bjork, 1994). In this way, both directed forgetting, an intentional forgetting phenomenon, and part-set cueing, an unintentional forgetting phenomenon, are types of retrieval inhibition. For clarity, consonant with Kimball and Bjork's application, impairment and interference are non-theoretical terms used to describe the empirical effects of the mechanisms of retrieval inhibition.

Directed Forgetting (DF)

Although first cited nearly 50 years ago (Brown, 1954; as cited in MacLeod, 2003), directed forgetting did not begin to proliferate until Muther (1965) and Bjork (1970) formalized the directed forgetting procedure. Since that time, list method directed forgetting has been extensively investigated. Most notably, list method directed forgetting has been found to reliably cause memory impairment for participants who are directed to forget previously learned information. This finding has been used to argue that the human memory system must possess a type of intentional forgetting mechanism. Additionally, list method directed forgetting also reliably results in recall benefits for list 2 of the forget group. That is, list 2 recall is improved for the forget group, relative to control. The benefits are interpreted as resulting from a lack of proactive interference from list 1, or alternatively, may result from a shift in encoding strategy from shallow to deep in the forget condition (Sahakyan & Delaney, 2003).

In the list method directed forgetting procedure "remember" or "forget" instructions are given between lists of words that are presented one at a time. In the forget condition, following the study of the first of two lists of words, the forget instruction "list 1 was only for practice, you won't be tested on it," is given. Conversely, the control group receives an instruction indicating that they should prepare to learn a second list. Following the learning of both lists, participants in both conditions engage in a distracter task to control for recency, which is followed by recall tests.

There are specific and subtle debates about the nature of the inhibitory mechanism of directed forgetting; however, despite these debates about the exact inhibitory mechanism, there is extensive agreement that directed forgetting is a result of some type of retrieval inhibition (Anderson & Bjork, 1994; Anderson et al., 1994; Basden & Basden 1998; Basden, Basden & Gargano, 1993; Bjork et al., 1998; Geiselman, Bjork, & Fishman, 1983; Sahakyan & Kelley, 2002). The evidence of inhibition rather than loss of memory availability comes from tests that circumvent retrieval processes and are highly sensitive measures of memory availability. For example, there are no reliable differences in recognition between forget and remember lists (Anderson et al. 1994; Basden & Basden, 1998; Basden et al. 1993). Also, item-relearning proceeds with similar efficiency for both forget and remember items (Bjork et al., 1998). As well, a re-exposure to some of the forget items results in a release from directed forgetting (Basden & Basden, 1998) as does cued recall following the learning of categorized lists (Basden, Basden, & Cokely, 2002). In sum, these studies demonstrate that directed forgetting results in retrieval inhibition such that information that is available is rendered inaccessible.

There are two leading theoretical accounts of the inhibitory mechanisms of directed forgetting. One account by Sahakyan and Kelley (2002) suggests that list method directed forgetting might be best interpreted as a type of context dependent cue-bias. Specifically, Sahakyan and Kelley demonstrated that in a list method directed forgetting procedure, the addition of a condition that uses a mental context-shift instead of a forget instruction reliably caused retrieval impairment of list 1 recall. Moreover, this 30-60 second between-list instruction to imagine a different context (e.g. imagine being invisible) caused participants to exhibit recall patterns highly similar to those of the forget condition of directed forgetting. Accordingly, Sahakyan and Kelley suggest that in directed forgetting participants may attempt to change internal contexts (trains-of-thought) following the forget instruction during a normal directed forgetting procedure. This shift in context apparently creates incongruence between the new context cues, which are still in effect at test, and the context cues that were encoded during the learning of list 1. In this way, the new context biases the memory search strategy such that the new context is used as a retrieval cue, resulting in a failed search. Additionally, Experiment 2 of the Sahakyan and Kelley series used a context reinstatement procedure at retrieval and found a significant reduction in the retrieval impairment of list 1 for forget participants and mental context participants, but not for participants who had been instructed to remember list 1.

A similar hypothesis proposed by Basden and Basden (1998) suggests that a strategy disruption is the inhibitory mechanism of list method directed forgetting. The strategy disruption results from an incongruence at recall between the strategy used to recall list 1 and that used at encoding. Basden and Basden argue that following a forget instruction a new encoding strategy is formulated to aid in the learning of list 2. Participants are then biased toward the use of this list 2 encoding strategy as a cue or strategy for retrieval of list 1. Again, parallel to the context account, because the retrieval strategy is different than the strategy used for encoding, a retrieval impairment results.

The Basden & Basden (1998) directed forgetting strategy disruption hypothesis relies on several lines of support. First, the strategy disruption impairment is theoretically predicted by the encoding specificity principle (Thomson & Tulving, 1970). Second, a disruption in strategy is evidenced by the typical pattern of increasingly randomized serial output order for forget items but not for remember items (Geiselman, Bjork, and Fishman, 1983). That is, retrieval output for the remember group often occurs in serial order, while the forget group suffers a disorganized retrieval. A third line of support comes from studies of output order interference. These studies reveal that when list output order is controlled, directed forgetting costs are diminished. That is, in free recall participants are more likely to recall list 2 first (Basden & Basden) increasing the effect of output interference, but also increasing the likelihood that the list 2 encoding strategy will bias the retrieval strategy used for list 1 recall. Finally, recent work by Sahakyan and Delaney (2003) indicates that a strategy shift from shallow to deep encoding occurs between list 1 and list 2 for the forget condition but does not occur in the remember condition. The shift in strategy thus creates the opportunity for a mismatch between the strategy used to retrieve list 1 and that used to encode list 1, in the forget condition.

Part-Set Cueing (PSC)

In a series of free recall experiments, Slamecka (1968) demonstrated a counter-intuitive phenomenon known as part-set or part-list cueing inhibition. In his experiment, following list learning, participants who were provided cues at recall experienced a memory performance impairment rather than the expected facilitation. Thus, providing cues at recall can impair rather than enhance memory performance. Further studies of the phenomenon have been extensive (Basden & Basden, 1995; Roediger & Neely, 1982) and suggest that the part-set cueing effect is caused by some type of retrieval inhibition, as the provided cues disrupt accessibility but not availability of the studied items.

The part-set cueing procedure is simple. In the experimental condition a list of words is studied and learned following an explicit instruction to memorize a list of items. Following list learning, a sub-set of the words is provided to cue the participants' recall of the entire list. Paradoxically, in comparison to the control condition, the cues cause impaired recall performance on both the overall proportion recalled and on the remaining uncued items.

Many theoretical explanations have been advanced to describe the mechanisms of part-set cueing. An early account of part-set cueing is drawn from Rundus' (1973) retrieval competition theory. Rundus' model suggests that list learning takes place via a process of forming a hierarchical association between list items and conceptual or other pre-experimentally determined groupings. The associative strength of these groupings is determined and subsequently shaped by incremental strength increases that result from sampling and practice. Recall of the items is then a probabilistic function of an item's association strength. Those items that are most strongly associated to groupings are the items that are the first and most likely to be output. Therefore, part-set cueing inhibition occurs because the presentation of some of the list items at test over-strengthens their association in memory. In this way, the increased association strength becomes so strong that retrieval is biased toward the production of the cued words, thereby blocking effective retrieval of the non-cued words. That is, as the cued words are activated their strength continues to increase, enhancing their accessibility and thus their ability to block the recall of other items.

A second leading explanation of part-set cueing inhibition comes from Basden and Basden (1995; Basden, Basden, & Galloway, 1977) and is supported by predictions of Raaijmakers and Shiffrin's (1981) SAM model, as well as the encoding specificity principle (Thomson & Tulving, 1970). Basden and Basden argue that the part-set cues disrupt participants' use of a retrieval strategy that closely matches their encoding strategy. Instead, the part-set cues cause one to generate a new strategy or are used as cues for retrieval. In either case, this new retrieval strategy is more likely to mismatch the way in which the items were organized and related during encoding, resulting in impaired retrieval performance. Strong evidence supporting the Basden and Basden retrieval disruption interpretation is the demonstration that randomizing the part-set cues causes greater impairment than does part-set cueing in serial presentation order (Basden & Basden, 1998). That is, the more dissimilar the cueing is to the encoding, the greater the recall impairment.

Overall, the Rundus (1973) retrieval competition theory is quite different from the Basden and Basden (1998) strategy disruption interpretation. The Rundus model suggests that the cueing blocks the retrieval of other items by making some items hyper-accessible in memory. That is, the impaired retrieval is always some function of the strengths of associations in memory. In contrast, Basden and Basden suggest that the cueing simply disrupts the strategy that is used for recall, and doesn't necessarily affect item strength. In this way, the strategy disruption mechanism is a meta-memory search mechanism, whereas the Rundus retrieval competition mechanism is a function of changes to the actual memory traces.

In sum, there is considerable consistency in theoretical interpretations of both part-set cueing and directed forgetting, with the exception of the Rundus retrieval competition interpretation of part-set cueing. Accordingly, the Basden and Basden (1998) and Sahakyan and Kelley (2002) theoretical accounts of directed forgetting and the Basden, Basden, and Galloway (1977) interpretation of part-set cueing all suggest that the observed retrieval inhibition is a product of a mismatch between encoding and retrieval events. Thus, these models are consistent with one another and consistent with an interpretation that a single mechanism may account for retrieval inhibition in both directed forgetting and part-set cueing.

Kimball and Bjork (2002)

In a series of two experiments, Kimball and Bjork (2002) investigated the effects of directed forgetting and part-set cueing on false memories produced by the DRM paradigm. In Experiment 1, Kimball and Bjork employed DRM lists in a standard list method directed forgetting procedure. Items were presented visually with an encoding duration of 2 seconds per word. List items showed the typical impairment pattern in response to the directed forgetting instructions. In contrast, false recall of critical lures actually increased in response to the directed forgetting instructions, suggesting that trying to forget increases false recollection.

In Experiment 2, in order to contrast the effects of intentional and unintentional forgetting, Kimball and Bjork (2002) studied the effects of part-set cueing on DRM lists. Encoding of DRM lists occurred at 1.5 seconds per word, via auditory presentation. Following the learning of each list, immediate recall was either cued or uncued with studied items. List item recall and critical lure recall were both impaired by part-set cueing. Therefore, in contrast to Kimball and Bjork's directed forgetting results, part-set cueing caused inhibition of false memories suggesting that unintentional forgetting reduces false recollection.

According to Kimball and Bjork (2002) the dissociation in false recall across directed forgetting and part-set cueing suggests that each procedure must rely on a different inhibitory mechanism(s). Therefore, they suggest that part-set cueing is a function of a Rundus (1973) type retrieval competition. That is, retrieval competition and changes in activation of memory strengths effectively block the output of the false memory. Conversely, Kimball and Bjork suggest that directed forgetting participants overcome the forgetting effects on the false memory because they rely on semantic associations to guide their memory searches. As a consequence, forget participants are lured toward recall of the critical lure because it is thoroughly semantically associated with all list items, thereby increasing their false recollection.

Although Kimball and Bjork's (2002) findings are suggestive, inconsistencies may have confounded their results. Most notably, although they find differences in inhibitory effects between part-set cueing and directed forgetting they also use different encoding modalities and encoding durations. In Experiment 1 (directed forgetting) list items were presented visually at a rate of 2 seconds per word. In Experiment 2, part-set cueing proceeds via auditory presentation at 1.5 seconds per word, followed by visual cueing. Additionally, there may have been between group differences in encoding, in Experiment 1, between forget and remember groups. That is, following the forget or remember instruction each group sat quietly for 30 seconds. Consequently, the 30 second unfilled interval might have allowed the remember group to rehearse and practice list 1 recall, while the forget group would not practice during this interval believing that they were not going to be tested on list 1. Thus, Kimball and Bjork's results may reflect properties of selective rehearsal or differential encoding, rather than retrieval inhibition.

In sum, these differences are not trivial. Other research has demonstrated that DRM materials are quite sensitive to factors including encoding modality, such that auditory encoding causes dramatic increases in false memory occurrence (Smith & Hunt, 1998) as compared to equivalent visual encoding durations. Moreover, McDermott and Watson (2001) demonstrate that there is a curvilinear relationship between encoding duration and false recall. At very short visual encoding intervals (20 v. 250 ms/word) false memory recall monotonically increased with greater encoding time. However, at longer intervals (1, 3, & 5 seconds per word) false recall waned, although veridical memory generally increased across all retention intervals. That is, without question, encoding times and modalities are critical variables that influence false recollection in the DRM paradigm.

In order to extend and clarify Kimball and Bjork's (2002) results a series of two experiments was conducted. The series was designed to assess the underlying relationships of false memory production and intentional or unintentional inhibition, and to evaluate other factors that may have affected Kimball and Bjork's findings. Moreover, the series was designed to assess the theoretical plausibility that a single mechanism could underlie both procedures. Specifically, Experiment 1 examined directed forgetting in the DRM paradigm while Experiment 2 examined part-set cueing in the DRM paradigm.

In contrast to Kimball and Bjork's (2002) experiments, these experiments both employed the same encoding duration and modality, a visual 1 second per word presentation. This encoding duration was selected as previous experiments suggest it more effectively produces false memories with visual encoding (McDermott & Watson, 2001) than the duration used by Kimball and Bjork. Moreover, the unfilled retention interval in Kimball and Bjork's directed forgetting experiment was eliminated. The prediction was that by using the same encoding time and modality, and controlling for the unfilled interval in directed forgetting, both procedures would result in similar inhibitory effects to false and veridical memories in the DRM paradigm. This finding would support the interpretation that a single mechanism may underlie both part-set cueing and directed forgetting. Specifically, it is my hypothesis that methodological discrepancies have confounded Kimball and Bjork's results and that better control of these variables will indicate that both procedures can have similar inhibitory effects for false and veridical recollection, and thus may be caused by the same mechanism.

Experiment 1: Directed Forgetting

Participants

Sixty-four undergraduate students from introduction to psychology classes at Florida State University were participants in partial fulfillment of requirements for the course, and were tested in groups of up to five.

Materials

The participants studied 2 pairs of DRM lists in blocked fashion, with words in each list presented in order from strongest to weakest associates. The critical lures of the list-pairs used were *soft* and *sweet,* and *rough* and *slow* (Roediger & McDermott, 1995). The selected list-pairs, the same as were used by Kimball and Bjork (2002), were chosen in order to control emotional valence and semantic associations between lists. The presentation of materials proceeded visually via PowerPoint and projector on a large screen in the front the room. Participants recorded all responses in writing in booklets that were provided.

Design

A two-factor design was used with instruction (forget instructions v. remember instruction) manipulated between-subjects and list (list 1 v. list 2) as a within-subjects factor, systematically counterbalanced for list-pair topics and within-list-pair presentation order. List 1 recall preceded list 2 recall in order to minimize output interference, following Kimball and Bjork (2002).

Procedure

The visual presentation duration of DRM words was set at 1 second per word. All participants were instructed to do their best and learn all of the presented words. Following the learning of list one, the participants in the forget group received the standard forget instructions (this list was only for practice…), while participants in the remember group received instructions that the first list was over and that they should prepare for the next list. Approximately 20 seconds elapsed between the learning of the first and second lists. This interval was filled with verbal instructions regardless of the condition. Following the learning of the second list a 30 second math task was used to control for recency and was followed by instructions to recall list 1. Two-minute recall intervals were used for list 1 and list 2 recall, with list 1 recall always preceding list 2.

Results

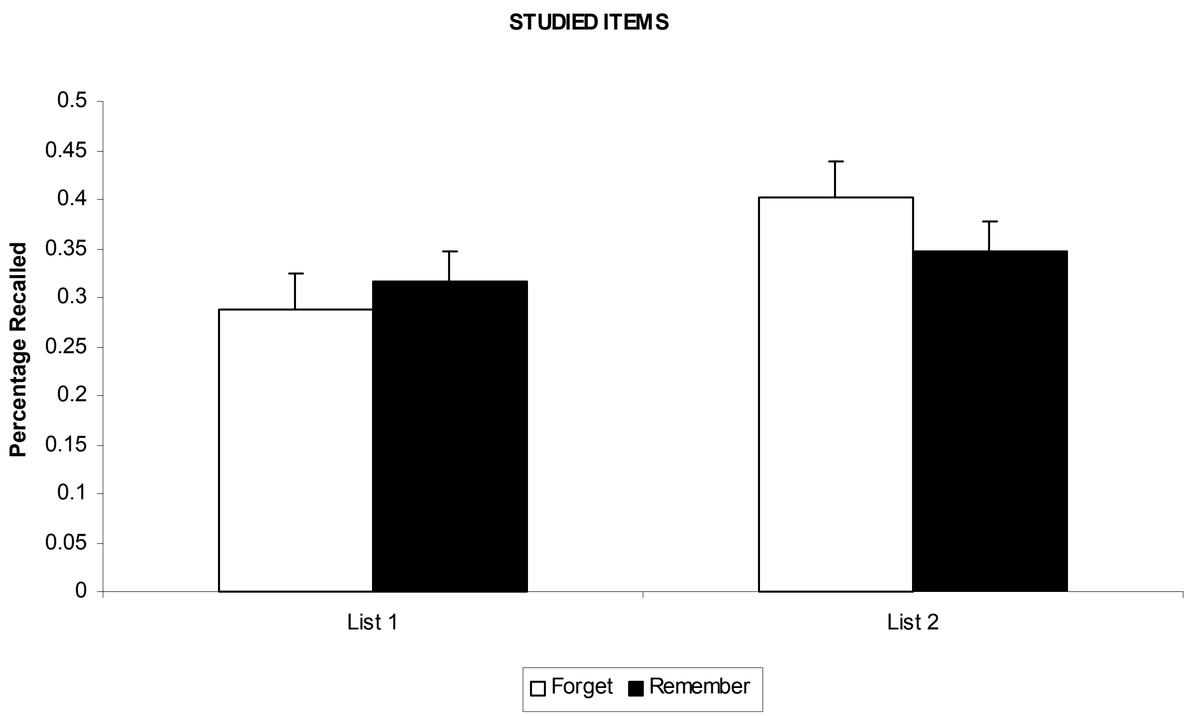

Figure 1. *Mean percentage and standard error of studied item recall in Experiment 1.*

Studied item recall. Unless otherwise noted the alpha level was set to .05. Following Kimball and Bjork (2002), recall of studied items was analyzed with a mixed model ANOVA with instructions (forget v. remember), list-pair topic, and within-list-pair presentation order as between factors, and list 1 versus list 2 as a within-participants factor. The two counterbalancing variables (list-pair topic or within-list-pair presentation order) did not interact with any other variable. A reliable instruction x list interaction $F(1, 56) = 4.10$, $MSe = 26.27$, $p = .048$ was revealed. This interaction reflects the standard directed forgetting results including list 1 costs and list 2 benefits, in the forget condition (see Figure 1 for results). That is, the interaction of the instruction and list reliably resulted in list 1 costs (*M* = .29) and list 2 benefits (*M* = .40) for the forget condition as compared to the remember group's list 1 (*M* = .32) and list 2 (*M* = .35) recall.

Critical lure recall. Chi-square analysis was used to analyze critical lure data, as each participant contributed one false recollection from list 1, at most, to the analysis. A significant main effect of instruction on list 1, χ^2 (1) = 5.79, was revealed. Critical lure output was reliably higher in the remember condition (*M* = 62.5%) than in the forget condition (*M* = 37.5%). This finding is contrary to that of Kimball and Bjork (2002) indicting that directed forgetting resulted in impaired false recall.

<u>Discussion</u>

In this case, directed forgetting instructions caused an inhibition of false recall. The differences in this procedure, as compared to that of Kimball and Bjork (2002), included a decrease in encoding duration from 2 seconds per word to 1 second per word. Additionally, Experiment 1 eliminated the unfilled retention interval following the learning of list 2. The 1 second per word visual encoding duration was chosen as it has been shown to provide higher rates of false recollection without causing substantial decreases in veridical recall (McDermott & Watson, 2001). These results likely differed from those of Kimball and Bjork (2002) and Seamon et al. (2002) because of the curvilinear encoding and false recollection relationship. That is, the effect of the inhibition in directed forgetting might be reasonably approximated by assuming the instruction to forget causes memory retrieval to behave as if it were based on poorer encoding. For example, at 2 seconds per word encoding, a forget group might exhibit recall performance similar to those in a remember group with 1 second per word, exhibiting more false recall than in a two second encoding remember condition. In contrast, with a one second encoding time, the instruction to forget may move performance to a decreasing false recall portion of the curve. In this way, Kimball and Bjork and Seamon et al. may have hit upon the optimal part of the curve for enhancing false memory recall. Specifically, according to McDermott and Watson (2001) false memory output is higher for encoding times that are shorter than 2 seconds per word, including 250 ms/word and 1 second per word. Therefore, retrieval inhibition might cause false recall in directed forgetting to move through the curve toward increasing levels of false memories (see Figure 2 for example).

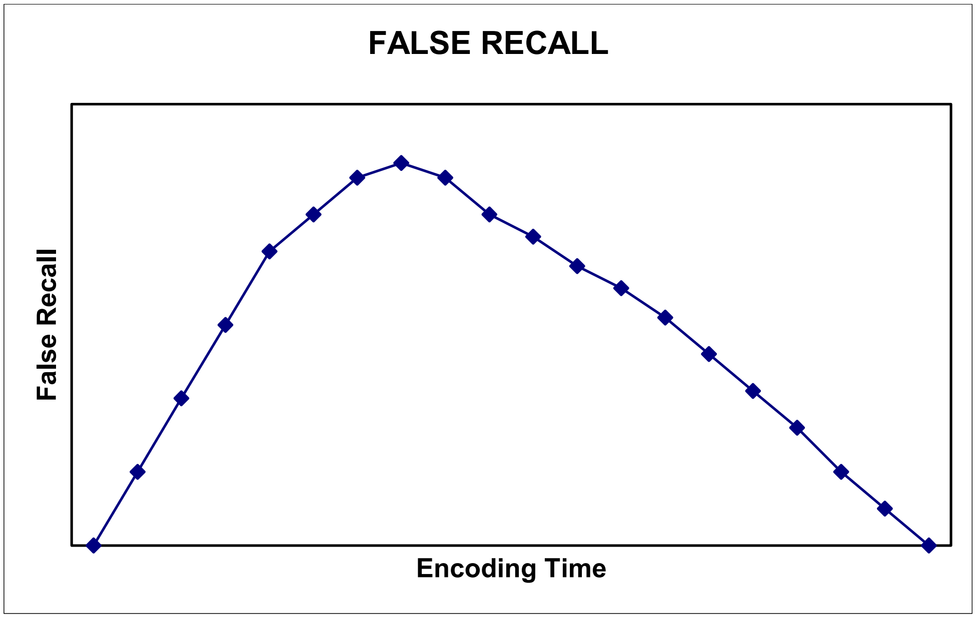

Figure 2. *Theoretical curvilinear relationship of encoding and false recall in the DRM paradigm.*

It is noteworthy that Kimball and Bjork (2002), in their directed forgetting experiment, report that their forget condition exhibited the highest frequency of false recall on record in the very extensive DRM literature. This finding suggests that their results may be anomalous such that the unfilled retention interval and 2 seconds per word encoding duration may have further magnified the differences between their part-set cueing and directed forgetting experiments. Likewise, confounding factors likely affected the Seamon et al. (2002) results. For example, Seamon et al. did not specify list output order and instead collected free recall responses, a practice know to increased output interference thereby confusing effects of the interference and directed forgetting (Basden & Basden, 1998). Moreover, they used extensively long lists of between 120 and 160 list items, another factor known to complicate or prohibit retrieval inhibition in directed forgetting. In sum, in marked contrast to Kimball and Bjork, and Seamon et al., these results suggest that when output interference, rehearsal opportunities, encoding load, and encoding duration are controlled, directed forgetting causes inhibition of both false and veridical memories.

Experiment 2: Part-Set Cueing

In Experiment 2, Kimball and Bjork (2002) compared their study of intentional forgetting with a study of unintentional forgetting. Using the part-set cueing paradigm Kimball and Bjork compared goal incongruent part-set cueing inhibition with the goal congruent impairment of directed forgetting. Experiment 2 uses the part-set cueing for DRM lists with the same encoding duration and with the same modality as was used in Experiment 1. I predict that part-set cueing will cause an impaired recall for both false and veridical recall.

Participants

Forty-eight students from introduction to psychology classes at Florida State University were participants in partial fulfillment of requirements for the course, and were tested in groups of up to five.

Materials

The participants studied 8 DRM lists in blocked fashion, presented in order from strongest to weakest associates. The critical lures of the lists used were *soft, sweet, rough, spider, needle, slow, river,* and *sleep*. The selection of the lists was made in accord with Kimball and Bjork's (2002) selections, although the *river* list was not included in their original experiment. The presentation of materials proceeded visually via PowerPoint, projected on a large screen in the front of the room, with participant answers recorded in writing in recall booklets.

Design

A single factor design was used with cueing (part-set cue v. no cue) manipulated within participants. Presentation was systematically counterbalanced for list-cue orders, employing 2 random list-set and cueing orders. Recall always immediately followed list learning, list by list, consonant with Kimball and Bjork (2002). Unlike Kimball and Bjork, all part-set cues were the 8 strongest associates of the critical lure, based on their findings that impairment was consistent across cues, with the strongest associates producing the greatest recall impairment.

Procedure

The visual presentation duration of DRM words was set at 1 second per word. This marks a departure from the auditory presentation in Kimball and Bjork (Experiment 2; 2002); however, this change was made to equate conditions across the part-set cueing experiment and the directed forgetting experiment. All participants were instructed to do their best and learn all of the presented words. DRM words appeared on the screen, blocked by list. At the end of each list, instructions appeared to recall as many words as possible. In the cueing condition, these instructions were accompanied by a list of the 8 strongest associates for that list. Each recall interval was 60 seconds, as in Kimball and Bjork's Experiment 2.

Results

Studied item recall. Recall was analyzed as either overall proportion recalled or was analyzed for the 7 weakest associates (non-cued items), regardless of part-set cueing condition. Both analyses yielded similar results; however, consonant with Kimball and Bjork (2002) only non-cued item recall is reported. Recall of studied items was analyzed with a mixed model ANOVA with list-cue order as a between factors variable, and part-set or no cueing as a within subjects factor. List cue order did not show a main effect ($F < 1$), nor did it interact with cueing condition, $p > .05$. There was a reliable within-participant effect of cueing, $F(1, 44) = 63.32$, $MSe = .553$, $p = .000$, where the cueing ($M = .30$) resulted in a significant recall impairment for study items compared to the uncued recall ($M = .46$).

Critical lure recall. Recall of critical lures was analyzed with a mixed model ANOVA with list-cue order as a between factors variable, and part-set or no cueing as a within subjects factor. The ANOVA revealed a reliable within-participant effect of cueing, $F(1, 44) = 8.621$, $MSe = 5.510$, $p = .005$. The counterbalancing variables (list-cue order) did not interact with any other variable. Cueing reliably impaired false memory production as well as impairing list item recall.

Discussion

Congruent with the findings reported by Kimball and Bjork (2002) and Reysen and Nairne (2002) these results suggest that part-set cueing inhibition reliably results in forgetting for both list and critical lure items. There are several key differences between Experiment 2 and earlier work. For example, Experiment 2 used a visual encoding modality (Reysen and Nairne, 2002) instead of an auditory presentation (Kimball & Bjork). Moreover, Experiment 2 used a 1 second per word encoding duration rather than the 1.5 seconds per word duration used by both Kimball and Bjork, and Reysen and Nairne. The results suggest that parallel to earlier research, at 1 second per word this type of unintentional forgetting results in retrieval inhibition of veridical and false recall.

General Discussion

In marked contrast to the results of Kimball and Bjork (2002), these experiments demonstrate that both directed forgetting and part-set cueing produce the same pattern of inhibitory results in the DRM paradigm. These two types of forgetting, one intentional and the other unintentional, did not demonstrate any dissociation in false recollection: both procedures resulted in an inhibition of veridical and false recollection. Moreover, contrary to the suggestion of Kimball and Bjork, our results suggest that part-set cueing and directed forgetting may stem from the same mechanism. That is, consistent with the Basden and Basden (1998) retrieval strategy disruption theory, when critical aspects of encoding were kept constant, both procedures resulted in similar patterns of retrieval impairment.

The Basden and Basden (1998) strategy disruption hypothesis is consistent with theoretical interpretations of the DRM paradigm and the effects of part-set cueing. For example, in part-set cueing with DRM materials, the part-set cues disrupt an individual's normal retrieval strategy. The new retrieval strategy differs from the encoding strategy and thus impairs retrieval of the prior encoding episode. In an activation/monitoring framework of DRM, because the new strategy mismatches the encoding episode all contents of memory are less accessible such that all recall performance for veridical and false recollection is lowered. Likewise, in a fuzzy trace DRM framework, the new strategy impairs access to both the verbatim and the gist traces. Because the gist trace is less accessible, it is not as effective at influencing retrieval, again resulting in an inhibition of false and veridical recollection, as was demonstrated in Experiment 2.

Theoretically, it is difficult to imagine how other competing hypotheses, like those based on Rundus' (1973) retrieval competition model, could account for our part-set cueing DRM results. That is, the Rundus inspired model of part-set cueing is not consistent with either the activation/monitoring or the fuzzy trace DRM frameworks. In terms of the activation/monitoring hypothesis, false recall occurs because the critical lure is highly semantically associated in memory with other list items and thus becomes highly activated and likely to be recalled, following list learning. According to the Rundus' retrieval competition interpretation the most strongly associated items in memory, namely the critical lures, are for the most part likely to be recalled. That is, the nature of the DRM list is such that the list items that are presented for learning are the items that are most strongly related to the critical lure. According to a retrieval competition interpretation, the critical lure then should have a very high probability and frequency of recall. In contrast, the data demonstrate the opposite results with lower recall of the critical lure in the part-set cueing condition.

The retrieval competition model has similar problems with the DRM fuzzy trace theory. According to fuzzy trace theory, the fading of the verbatim trace leads to higher reliance on the gist trace, which is highly influenced by semantic features overlap. This makes fuzzy trace and the Rundus retrieval competition theory, as applied to part-set cueing, quite incompatible. That is, the derivation of the DRM materials was performed by analyzing participants pre-existing semantic associations. The critical lures themselves are the strongest associates of the presented items (Gallo & Roediger, 2002). Because all items share the central theme of the critical lure, the critical lure should be highly active and associated to all items in the gist trace. Thus, the most highly associated aspects of the gist representation, the critical lure, should have the highest probability of recall. This is contrary to all earlier findings, where part-set cueing reduces false recall.

Turning to directed forgetting, the two leading theories, the Basden and Basden (1998) strategy disruption hypothesis and the Sahakyan and Kelley (2002) context-shift account, are both consistent with the results of Experiment 1 and are consistent with each other. Again, both accounts of directed forgetting suggest that the cause of the retrieval impairment is a mismatch between aspects of encoding and retrieval contexts. The key difference between the interpretations is the temporal locus of the contextual mismatch. That is, Sahakyan and Kelley suggest that the context change takes place between the learning of list 1 and list 2, and endures through retrieval. The Basden and Basden account suggest that the mismatch occurs primarily at retrieval although the impetus for the change, an initial shift in encoding strategy, is initiated following the forget instruction. Therefore, according to Basden and Basden and Sahakyan and Kelley the inhibitory mechanism of directed should be able to cause a general impairment in both veridical and false recollection for certain encoding durations, as was evidenced in

Experiment 1.

To account for the dissociation between the directed forgetting results of Experiment 1 and those of Kimball and Bjork (2002) and Seamon et al. (2002) a review of the encoding dynamics is necessary. In particular, the curvilinear relationship of encoding and production of on false memories, but not veridical memories, appears to be of central import. Specifically, in directed forgetting, DRM false memories are inhibited when the list items are presented at a rate of 1 second per word, yet appear to be facilitated with 2 seconds per word encoding (Kimball & Bjork, 2002; Seamon et al., 2002). These dissociative findings may simply be results of unintentional confounds such as the unfilled retention interval, some list-length effects, and the output interference that was detailed in the Experiment 1 results section; however, they may also reflect boundary conditions for false recall in directed forgetting resulting from the DRM curvilinear encoding and recall relationship. For example, according to the activation/monitoring hypothesis, the probability of falsely recalling the critical lure is a function of both the activation of the critical lure and monitoring of memory source detail. In this way, false recollection depends on encoding list items well enough to activate the critical lure, but not so well as to support perfect monitoring at test. In the latter case, participants would be able to discriminate between the critical lures and other list items because the lures would lack the same level of distinctive detail, thereby allowing memory monitoring to exclude the recall of the critical lure.

Conceivably, at longer encoding durations in directed forgetting such as 2 seconds per word the effect of the forget instruction is to disrupt access to details important for monitoring. Again, inhibition in directed forgetting might be roughly approximated by assuming the forget condition will behave as if it had a shorter encoding duration. In this way, at 2 seconds per word all list items in the forget condition including the highly activated critical lure might behave as if they were encoded for only 1 second per word. As McDermott and Watson (2001) demonstrate, false recollection at 1 second per word is greater than at 2 seconds per word perhaps because the shorter encoding duration limits the opportunity to encode a detailed source memory. This lack of details would then increase the rate of false recall as the highly activated critical lure would be easier to recall and yet wouldn't otherwise be distinctively different than other items. Thus, the predicted pattern of results would include a decrease in the rate of veridical recall, because there would be fewer details accessible to guide retrieval, despite an increase in the rate of false recollection, as was seen for both Kimball and Bjork (2002) and Seamon et al. (2002).

In contrast, at faster encoding rates, such as with the 1 second per word used in Experiment 1, details would be sparse for both forget and remember groups because the shorter encoding duration limits participants' ability to elaborately encode source details. In this way, retrieval inhibition induced by the forget instruction would primarily act on the activation of the critical lure. The forget group would then have less access to all items including the critical lure and should show an inhibition of both false and veridical memories, as was demonstrated in Experiment 1.

Given the influence that encoding durations have on directed forgetting, speculation on the effect that encoding has on part-set cueing is necessary. Notably, pilot testing of longer encoding durations (3 seconds per word) in part-set cueing suggest that recall of both veridical and false memories is impaired. This lack of a dissociation based on encoding duration may simply reflect the greater effect size of part-set cuing manipulations. That is, part-set cueing is very robust and likely results in reliably larger inhibitory effect sizes than directed forgetting. This difference thereby could obscure some of the variability seen at longer encoding durations in directed forgetting. However, it remains to be seen if there are conditions under which part-set cueing actually increase false recall in the DRM paradigm.

In sum, Experiments 1 and 2 demonstrate that retrieval inhibition can have similar effects on false memories, regardless of one's intention to remember or forget. Retrieval inhibition induced by part-set cueing and directed forgetting causes the same pattern of impairment for both veridical and false recollection, as long as encoding conditions are matched, opportunities for selective rehearsal are minimized, and the influence of the curvilinear DRM false recall and encoding relationship is taken into account. Thus, one's intention to remember or forget is not necessarily a critical variable in the production of false memories. Moreover, these findings are consistent with a parsimonious single mechanisms interpretation of both procedures (Basden & Basden, 1998). In this way, simple fluctuations in context and strategy can account for the inhibitory behavior seen in both directed forgetting and part-set cueing.

Conclusion

In their closing, Kimball and Bjork (2002) caution us to recognize the influence that intention has on the production of false memories. They argue that the dissociation in false memory production across intentions is of pragmatic value and likely has clinical import. Rather than challenge their notice, these results compliment and extend it. I suggest that not only are the retrieval dynamics critical variables, but so too are the encoding dynamics, which in some ways are even more influential. Moreover, these lessons are also valuable and important for other social and legal domains, including recognizing the dangers of sleeper-type effects and the shortcomings of jury instructions to forget inadmissible evidence (Golding & Long, 1998). Notably, it may be the case that retrieval inhibition in directed forgetting generally causes source memory impairments thereby disrupting effective memory monitoring, which in some cases will lead to increases false recollection (Bjork & Bjork, 2003). In sum, as might be the case for victims of abuse or violent crimes, it is important to recognize that one's degree of susceptibility to false memories is largely determined by the quality of one's encoding, rather than simply by one's desire to remember or forget.

APPENDIX A

IRB APPROVAL

Florida State
UNIVERSITY

Office of the Vice President
For Research
Tallahassee, Florida 32306-2763
(850) 644-5260 · FAX (850) 644-4392

REAPPROVAL MEMORANDUM
from the Human Subjects Committee

Date: 9/17/2003

Colleen M. Kelley
MC: 1270

From: **David Quadagno, Chair**

Dept.: **Psychology**

Re: **Reapproval of Use of Human subjects in Research:**
Long-Term Memory

Your request to continue the research project listed above involving human subjects has been approved by the Human Subjects Committee. If your project has not been completed by 9/20/2004 please request renewed approval.

You are reminded that a change in protocol in this project must be approved by resubmission of the project to the Committee for approval. Also, the principal investigator must report to the Chair promptly, and in writing, any unanticipated problems involving risks to subjects or others.

By copy of this memorandum, the Chairman of your department and/or your major professor are reminded of their responsibility for being informed concerning research projects involving human subjects in their department. They are advised to review the protocols of such investigations as often as necessary to insure that the project is being conducted in compliance with our institution and with DHHS regulations.

Cc:
HSC No. 2003.501-R

APPENDIX B

INFORMED CONSENT FORM

INFORMED CONSENT FORM: LONG-TERM MEMORY

I freely and voluntarily consent to be a participant in the research project entitled "Long-term Memory".

I have been informed that Dr. Colleen Kelley, an Associate Professor in the Department of Psychology at Florida State University has requested my participation in a research study at Florida State University.

The purpose of this research is to understand how people's memory functions.

My participation will involve studying either words, pictures of objects, or paragraphs, followed by a test of my memory for the material I have studied. The experiment will last approximately an hour. My performance on the memory test will be confidential to the extent allowed by law. No individual results of the experiments will ever be reported.

The experiment does not in any way constitute a risk to me. I understand that I will receive course credit for this experiment.

My consent may be withdrawn at any time without prejudice, penalty, or loss of benefits to which I am otherwise entitled. That is, my grade in the course will not be affected if I choose to withdraw from the experiment, nor will I receive an experiment credit penalty. However, I will still be obliged to fulfill my experiment participation obligation for the General Psychology course.

I may contact Dr. Kelley (644-3816) if I have questions about this project. If I have any questions about my rights as a participant in this research, or if I feel I have been placed at risk, I can contact the Chair of the Human Subjects Committee, Institutional Review Board, through the Vice President for the Office of Research at 644-8633.

I have read and understand this consent form.

________________________ (participant)

________________________ (date)

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BIOGRAPHICAL SKETCH

Edward Tucker Cokely was born in Santa Clara, California. He earned a B.A. in Psychology, with an emphasis in Cognitive Neuroscience, from the California State University, Fresno, in 2001. He is a devoted teacher and has received awards for instructional excellence at both Fresno State University and Florida State University. Additionally, he has authored or co-authored research published and presented at regional, national, and international conferences. His current research interests consist of basic and applied topics in the cognitive sciences, including memory, attention, and (natural and artificial) intelligence.