DISSERTATION

ISOLATING PARTIAL RECOLLECTION AS A DISTINCT ENTITY IN RECOGNITION MEMORY USING A MODIFIED RECOGNITION WITHOUT IDENTIFICATION (RWI) PARADIGM

Submitted by

Anthony J. Ryals

Department of Psychology

In partial fulfillment of the requirements

For the Degree of Doctor of Philosophy

Colorado State University

Fort Collins, Colorado

Summer, 2012

Doctoral Committee:

Advisor: Anne M. Cleary

Carol S. Seger
Benjamin A. Clegg
Vicki J. Volbrecht
Dawn Rickey

ABSTRACT

ISOLATING PARTIAL RECOLLECTION AS A DISTINCT ENTITY IN RECOGNITION MEMORY USING A MODIFIED RECOGNITION WITHOUT IDENTIFICATION (RWI) PARADIGM

In dual-process recognition memory research, recollection is believed to involve bringing to mind a specific prior occurrence, a target item, or the contextual details surrounding a past experience. Prior research has suggested that when recollection fails, individuals can still rely on a sense of familiarity to judge whether something has been experienced before, and the two processes may be dissociable. However, many recognition memory methods index recollection in a binary fashion such that it is treated as an all-or none occurrence. To the contrary, some research suggests that recollection may actually be a variable (i.e., a "some-or-none") process. In the present study, three experiments were conducted to explore the nature of partial recollection using a variation of the recognition without identification procedure (RWI) (Cleary, 2006; Cleary & Greene, 2000; Peynircioglu, 1990). In Experiment 1, I explored the hypothesis that manipulating the amount of perceptual information present at encoding in a recognition task can modulate the likelihood of partial recollection (Parks et al., 2011). In Experiment 2, I examined whether partial recollection responds to word frequency in a manner similar or different than full target recollection or familiarity. In Experiment 3, I explored whether partial recollection, like full target recollection, could also be affected by manipulating degree of target emotionality. In this work, I demonstrate that partial recollection is a distinct, albeit rare, factor in studies of human recognition memory

DEDICATION

~ I first dedicate this dissertation to my wife Meg and my daughter Sayarah. Thank you both for your patience and understanding during graduate school. We made it! I love you!

~ I would also like to dedicate this dissertation to my brother Jody. You were the reason for my passion for discovery in Psychology. Whether you know it or not, you have always been a driving force behind my work. You will continue to be a source of inspiration in my career.

~ Finally, I would like to dedicate this dissertation to the memory of Daniel Dueppen, Marc Richard, Will Szlemko, and Dr. David McCabe.

TABLE OF CONTENTS

CHAPTER I: Introduction……..1

CHAPTER II: Traditional Dual Process Theory……...3

CHAPTER III: Partial Recollection: Evidence from Studies of Recognition Memory…….. 7

Partial Recollection and Source Memory Judgments…….. 11

CHAPTER IV: Evidence from Metacognition Research……..……...……12

CHAPTER V: Evidence from Anomic Aphasia…….…..14

CHAPTER VI: Evidence from Tip-of-the-tongue States……...….16

CHAPTER VII: Creating the Potential for Partial Recollection: Complexity……..……...18

CHAPTER VIII: Additional Factors: Word Frequency and Emotionality……..…21

Word Frequency…….…...26

Emotionality…….….27

CHAPTER IX: The Recognition without Identification (RWI) Method……...……..26

CHAPTER X: The Present Study……...…..29

CHAPTER XI: Experiment 1……..…….32

Method…….33

Results and Discussion……35

CHAPTER XII: Experiment 2 …….……..…….48

Method…….49

Results and Discussion……51

CHAPTER XIII: Experiment 3……..…….…….66

Method…….67

Results and Discussion……69

CHAPTER XIV: General Discussion……..82

Perceptual Complexity…….....82

Word Frequency……..….83

Emotionality……..…84

Partial Retrieval: Purposeful or Incidental?.....85

The Distinctiveness of Partial Recollection and Implications for Theory…….....87

On the Apparent Rarity of Partial Recollection……...89

Modeling Partial Recollection……..90

Limitations and Future Directions……...91

Conclusions……..92

REFERENCES……..94

APPENDICES…..……107

"Abruptly the poker of memory stirs the ashes of recollection and uncovers a forgotten ember, still smoldering down there, still hot, still glowing, still red as red."
~William Manchester~ (1922-2004)

Isolating Partial Recollection as a Distinct Entity in Recognition Memory using a Modified Recognition without Identification (RWI) paradigm.

Chapter I

Introduction

It is likely that every individual has experienced the uncomfortable sensation of attempting to retrieve an item from memory only to find the target inaccessible. For example, perhaps an individual is unable to retrieve the name "*Natalie Portman*" when describing her role in the film "*Black Swan*". Perhaps it is a failure to conjure up the name of the composer "*Barber*" when hearing his song "*Adagio for Strings*" being played in a restaurant. Maybe it is the inability to retrieve the identity of a bird as an "*American Goldfinch*" when watching it eat from your birdfeeder. In each of these scenarios, it is possible that the failure to reach a target in memory results in a mere feeling of familiarity in the target's absence. However, it seems that the ability to retrieve partial details in such a case is substantively different than a feeling of familiarity with no contextual information. For instance, is it still possible to remember that Natalie Portman's character played the role of Princess Odette in the ballet Swan Lake? Is it still possible to remember that "*Adagio for Strings*" was used in the soundtrack to "*Platoon"?* And might it be possible to remember that the species of bird eating from your birdfeeder can sing quite well? In each of these cases, it is possible to retrieve partial information about an intended target in memory while still failing to reach the target itself.

The underpinning of the ability to retrieve partial information remains relatively unknown in experimental cognitive psychology. In the domain of recognition memory, which is

the study of the ability to realize that something has occurred previously, dual-process theories have begun to acknowledge the possibility that partial retrieval exists and that it may be an important factor. The current study attempted to provide evidence in support of partial recollection as a distinct entity in recognition memory using a novel experimental paradigm. Partial recollection may be distinct from full recollection. In a series of three experiments, I sought to use a relatively new method to offer empirical evidence that partial recollection is distinct from recollection (i.e., full target identification) as well as from familiarity-based recognition that occurs when identification fails.

Chapter II

Traditional Dual Process Theory: Recollection, Familiarity and the Original Debate

One of the most tenuous debates in the last two decades of recognition memory research concerns whether familiarity-based recognition is distinct from recollection. According to dual-process theories of recognition memory, recollection involves retrieving a prior experience through a binding of contextual information to item information in order to create a coherent experience in time. In comparison, familiarity involves a feeling of having experienced something coupled with the inability to bring to mind the item or event itself or any associated contextual details (e.g., Diana, Reder, Arndt, & Park, 2006; Mandler, 1980; Mandler, Pearlstone, & Koopmans, 1969; Yonelinas, 2002; 2010). Using a previous example, recollection would be the ability to retrieve the name "*Samuel Barber*" upon hearing his song. In contrast, familiarity would involve a striking sense of having heard the song before accompanied with an inability to retrieve any details about it.

One of the more widely-endorsed dual-process models, the dual-process signal detection model (DPSD), combines a strength-based familiarity process modeled on a signal detection distribution and a high threshold process to explain recollection. That is, a memory must exceed a criterion in order to trigger recollection, otherwise it remains familiarity devoid of context (e.g., Yonelinas, 1997; 2002; Parks and Yonelinas, 2007). While recollection in this threshold/detection model is typically associated with the high confidence ratings, subthreshold activation is associated with lower confidence ratings.

At least four experimental methods have traditionally been used to separate recollection from familiarity. One of the most frequently used methods is the Remember/Know (R/K)

procedure (Tulving, 1985). In a typical R/K experiment, participants study a series of items (e.g., words, pictures). At test, participants view both studied and nonstudied items. For each item, they must judge whether it was studied or nonstudied. For "studied" responses, participants indicate whether they "remember"(R) or "know" (K) that the item was studied. An "R" response indicates they can recall seeing an item before within the context of the experiment. A "K" response indicates they merely feel they have experienced an item earlier in the experiment but cannot recollect its prior occurrence. "R" responses are interpreted as an index of recollection, and "K" responses are interpreted as an index of familiarity. Additional methods used to study recognition memory include the process dissociation procedure (Jacoby, 1991), the signal-lag procedure (Hintzman & Curran, 1994), and receiver operating characteristics or ROCs (Yonelinas, 1994); though each method has its own set of controversial problems (see Yonelinas, 2002; but see Wixted & Stretch, 2004).

Research in the last two decades has provided convergent support for dual rather than single processes in recognition. One line of evidence from experimental cognitive psychology includes functional dissociations such as those involving levels of processing (Craik & Lockhart, 1972; Rajaram, 1993) and divided attention (Gardiner & Parkin, 1990; Jacoby, 1991). A second line of evidence comes from neuropsychological dissociations in anterograde amnesic populations (e.g., Scoville & Milner, 1957; Milner, 2005) and in neurological cases of medial temporal lobe lesions that spare the hippocampus (Bowles et al., 2007; 2010). A third line of evidence comes from neuropharmacological manipulations that impair recollective binding but spare familiarity-based discrimination (e.g., Reder, 2009; Reder et al, 2006). Additional evidence also comes from cognitive neuroscience. For instance, magnetoencephalographic (MEG) and event-related potential (ERP) data have suggested that familiarity may be temporally distinct

from recollection (e.g., Rugg & Curran, 2007; Curran & Cleary, 2003; Ryals, Yadon, Nomi, & Cleary, 2011; Voss & Paller, 2006; 2009). Functional neuroimaging (fMRI) suggests these two processes may be spatially distinct as well (e.g., Carr, Rissman, & Wagner, 2010; Diana, Yonelinas, Raganath, 2010).

In contrast to traditional dual-process theories, single-process theorists have contended that recollection and familiarity can both be explained by a single strength-based continuum of familiarity using a signal detection distribution (e.g., Dunn, 2004; Macmillan & Creelman, 2005; Shiffrin & Steyvers, 1997; Slotnick & Dodson, 2005; Wixted, 2007a, 2007b; Wixted & Stretch, 2004). The single-process argument is largely based on parsimony, such that it does not demand the amount of theoretical complexity necessary in the DPSD. Given that the weight of the evidence has tended to favor dual process over single process theory in studies of recognition memory, the focus of the *original* debate has shifted somewhat. That is, the nature of the recognition debate is no longer truly about single versus dual approaches. In fact it has been stated that most researchers now accept one form or another of a dual process model (e.g. Rugg & Curran, 2007). The current debate in the field of recognition memory literature now largely concerns *what kind* of dual process model can serve to best explain the data. Moreover, some theorists have proposed models suggesting that recollection may be more complex than has traditionally been thought.

One example is the “some or none” variable-recollection dual process (VRDP) model (e.g., Macho, 2004; Onyper, Zhang, & Howard, 2010; Sherman, Atri, Hasselmo, Stern, & Howard, 2003). Like DPSD models, the VRDP model allows for a strength-based familiarity dimension; however, the VRDP model assumes that recollection is based on a continuum of activation rather than a threshold. Onyper et al. argue that although recollection in their model is

continuous, it can still fail, and when it completely fails, familiarity can be used to discriminate old from new items. Thus, although the VRDP model suggests that, when full target recollection fails, partial information can be retrieved in varying degrees, recollection can still altogether fail so that nothing at all is recollected, and in those cases, familiarity can still allow recognition to take place.

While it is argued that the unequal variance signal detection model (UVSD) traditionally provides a better fit for words, the DPSD has traditionally provided a better fit for scenes (Onyper, Zhang, & Howard, 2010). In reconciliation of these two views, the VRDP model is able to account for the full pattern of results in the literature better than either the UVSD or DPSD. New models such as the VRDP that extend traditional understanding may be integral in advancing the understanding of recognition memory. Though somewhat new to recognition memory models, the hypothesis that graded (i.e., partial) recollection can occur when full target recollection fails is not without precedent however.

Chapter III

Partial Recollection: Evidence from Studies of Recognition Memory

One of the first experiments to address partial recollection was conducted by Yonelinas and Jacoby (1996). Using the process dissociation procedure (PDP) developed by Jacoby (1991), Yonelinas and Jacoby sought to determine if non-criterial recollection (i.e., recollection not central to the task) operated independently from recollection. Their findings suggested noncriterial recollection influenced familiarity *but not* criterial recollection. Although they acknowledge the existence of partial recollection, Yonelinas and Jacoby (1996) also suggested that it is an automatic occurrence that is inconsequential to full target retrieval. Furthermore, they suggested there is no evidence that partial recollection is functionally distinct, thus it is best treated as familiarity.

Hicks, Marsh, and Ritschel (2002) provided some evidence that partial recollection may be similar to the recollective details necessary for accurate source memory monitoring. Hicks and colleagues hypothesized that partial recollection should lead to accurate source monitoring performance independent of *R* judgments in the R/K procedure (Gardiner, 1988; Gardiner, Gawlik, & Richardson-Klavehn, 1994; Tulving, 1985). In Experiment 1, Hicks, Marsh, and Ritschel (2002) presented participants with seen or spoken words at study, and then at test had them make source judgments about each word (i.e., was the word seen, spoken, or new?). If the participant chose seen or spoken, they were then asked to make an R or a K judgment. Results indicated no reliable differences between R or K responses for accurate source judgments in both the seen and heard conditions, thus the researchers concluded that accurate source monitoring may occur outside of full recollection in the R/K paradigm.

In Experiment 2, Hicks et al. (2002) had participants solve anagrams during study trials and then determine if test items were generated, seen, or new. As in Experiment 1, a "generated" or "seen" answer initiated an R/K judgment. Correctly attributed generated items led to higher R than K responses, but a crossover interaction appeared, such that correctly attributed seen items led to higher K than R responses. Hicks et al. proposed that decisions based on partial information can "use a variety of information that varies in its degree of clarity" (p. 506). They also suggested that accurate source monitoring can occur based on partial information outside of full recollection as defined by the R/K paradigm. Given that K judgments are often interpreted to reflect pure familiarity, Hicks et al. also suggested that the K dimension of R/K may need to be reconsidered because partial recollection can differ substantially from familiarity. The binary nature of the R/K procedure may require that partial recollection fall into the K category despite that the experience of partial recollection may be quite unique from both the R and the K categories.

Cook, Marsh, and Hicks (2006) conducted a series of five experiments which offered additional evidence for the existence of partial recollection. In each experiment, participants paired visually presented words with auditorily presented words spoken in either a male or a female voice. These associates were learned in either an intentional or an unintentional manner. At test, cue words were presented, and participants were asked to recall the studied target associate. For example, if the participant were asked to study the pair *robin-orange*, perhaps *robin* appeared on the computer screen and they then paired it with *orange* spoken by a male or female voice. At test, they may have been presented with just the cue *orange* and, they would have been asked retrieve its associate. For recalled items, participants made a voice gender source judgment and then advanced to the next trial. For items for which associative cued recall

failed, participants were asked to make an initial source judgment, choose the correct target out of four possible choices, and then make a final source judgment. In Experiment 2 Cook et al. demonstrated that partial contextual information is available at test, but only when study items are well encoded. This finding suggests that standard recognition tasks are not optimally set up to tap partial recollection and that special circumstances may be needed to probe the phenomenon. In summary, Cook et al. (2006) proposed that partial information can occur outside of full recollection and that such information may be an important mediator for source judgment accuracy. Furthermore, Cook et al. suggest partial recollection may play a role in feeling-of knowing (FOK) and tip-of-the-tongue (TOT) states.

An additional piece of evidence in favor of the existence of partial recollection comes from an aging study conducted by Toth and Parks (2006). A common observation in healthy aging is a decrease in recollection but preserved familiarity. (e.g., Howard, Bessette-Symons, Zhang, & Hoyer, 2006; Parks, DeCarli, Jacoby, & Yonelinas, 2010). Toth and Parks hypothesized that if noncriterial recollection is analogous to familiarity as Yonelinas and Jacoby (1996) suggested, then older adults should retain the ability to exhibit partial recollection while demonstrating decreases in full recollection. Toth and Parks utilized the PDP procedure from Yonelinas and Jacoby (1996) to compare performance in younger and older adults. Toth and Parks replicated the finding of an increased influence of noncriterial recollection on familiarity estimates for younger adults, but this effect was not found for older adults. In fact, familiarity estimates were reduced for older compared to younger adults using this method. Toth and Parks suggest that partial recollection reflects contextual information that is independent of full recollection and familiarity. That partial recollection increased familiarity estimates in younger but not older adults suggests that the PDP procedure may be inherently limited in its ability to

parse partial recollection from familiarity. If this is true, then familiarity and partial recollection should not be treated as functionally equivalent. Toth and Parks (2006) proposed that partial recollection is a real memory phenomenon that is "dissociable and measurable", and they suggest that common recognition paradigms (e.g. PDP, R/K) may not fully tap it. Importantly, Toth and Parks also suggested that only through the use of "richer and more complex stimuli" (p. 535) may we come to understand the role that partial recollection plays in true episodic memory.

To explore additional hypotheses created by the findings from Toth and Parks (2006), Parks (2007) used the R/K procedure to examine younger adults under full attention conditions, younger adults under divided attention conditions, and older adults. Parks created three test conditions (easy, difficult, and broad) which manipulated task demands, and she hypothesized that effects of noncriterial recollection should be reduced for younger adults under divided attention and older adults relative to the full-attention younger adults. The easy condition entailed identifying the voice a word was spoken in. The difficult condition entailed having to recollect whether a word was spoken into the left or the right ear. The broad condition required participants to retrieve *any* detail about the studied word. Findings suggested an overall reduced effect on familiarity for the young divided attention and older adult groups compared to the full attention young adults. In Experiment 2, Parks modified the method used in Experiment 1 (with just the broad and hard conditions) to accommodate the DPSD model. Recollection and familiarity estimates were computed in accordance with DPSD and also plotted using receiver-operating characteristics (ROC) curves. Results suggested that the influence of noncriterial recollection was larger for the younger adults than the older adults and that noncriterial recollection operates in a manner similar to criterial recollection without influencing familiarity.

Partial Recollection and Source Memory Judgments

Partial recollection is notably similar to source memory judgments. Source memory tasks are those in which an individual is required to correctly identify the source of a memory such as the location of a previously seen object, the background color of a previously viewed item, or the gender of a speaker (e.g., Johnson, 1997; Johnson & Mitchell, 2002, Johnson & Raye, 1981; Mitchell & Johnson, 2009). Source memory tasks are largely believed to rely on recollection, whereas item recognition tasks are believed to rely on familiarity (e.g. Johnson, Hashtroudi, & Lindsay, 1993; Yonelinas, 2002). The source memory literature offers some evidence suggesting that individuals are able to recall variable degrees of information (Dodson, Holland, & Shimamura, 1998). In Experiment 1, Dodson et al., had participants study words spoken by either two different males or two different females. Even when participants failed to retrieve the name of a given speaker on a later source memory test, they were often able to correctly recollect the gender of the speaker. In a subsequent experiment, Dodson et al. found that dividing attention at encoding disrupted later target recollection but not recollection of gender identification. In a later study, Slotnick (2010) provided evidence suggesting that UVSD models provided a better fit for source-memory ROCs than threshold DPSD models using a combination of R/K and source-memory confidence judgments. Slotnick suggested that recollection, like familiarity, is best explained by a continuous process.

Chapter IV

Evidence from Metacognition Research

Support for the existence of partial recollection also comes from the metamemory literature. Koriat, Levy-Sadot, Edry, and de Marcas (2003) proposed that partially-retrieved information can be structural, phonological, or semantic in nature. An example of structural or phonological partial information might be failing to recollect the name of a bird sitting at your birdfeeder but knowing that its name starts with a "g". Semantic partial recollection might involve failing to retrieve its name but knowing that it is a species especially fond of sunflower seeds. Koriat and colleagues argue that partial recollection can occur in a direct mode, whereby an active search for partial clues in memory occurs. Such access to partial information manifests through demonstrations of partial information such as the first letter of the target: (". . . it is a grouse . . . no, a goldfinch . . .").

In Experiment 1, Koriat et al. (2003), had participants study Hebrew words which were paired with nonsense (pseudo-Somali) letter strings. At test, just the pseudo-Somali cues were shown, and participants had to recall each Hebrew associate. In the event that participants failed to recall a given word, they were asked to rate its semantic polarity by using good-bad, strong-weak, and passive-active judgments. Koriat et al. found that even when unable to retrieve a desired target word, participants were able to reliably judge its correct semantic polarity. Experiment 2 used a similar procedure with the addition of R/K judgments (with "guess" and "don't know" options added). In replication of Experiment 1, participants made accurate semantic judgments of partial information in the absence of target recall. Furthermore, partial information was associated with fewer overall R responses and more K and "guess" responses than actual recall. Even so, the fact that partial information *was* sometimes associated with R

responses suggests that recall can be variable. In sum, Koriat et al. (2003) presented intriguing data suggesting the characteristics of partial recollection can be quite different from full recollection as well as feelings of familiarity in the absence of recollection.

Chapter V

Evidence from Anomic Aphasia

Anomic aphasia is a language disorder defined by a disruption in the production or comprehension of meaningful speech not caused by sensory or motor deficits (NIH, 2011). A unique first-person account of anomia is presented by cognitive psychologist Mark Ashcraft (1993). After experiencing a seizure while working at Cleveland State University, Ashcraft documented his 45-minute episode and published it in the journal *Brain and Language*. Due to a malformation in brain vasculature in his left hemisphere, Ashcraft's seizure caused what is known as transient (temporary) anomia. After his anomia, Ashcraft wrote about the "dissociation between a thought and the word or phrase that expresses the thought" during the episode. Ashcraft illustrated his awareness of an intention to communicate despite the inability to do so in the passage below:

> The subjective experience consisted of knowing with complete certainty the idea of concept that I was trying to express and being completely unable to find and utter the word that expressed the idea or concept. The thoughts can only be described in sentence-like form, because they were as complex, detailed, and lengthy as a typical sentence. They were not sentences, however. The experience was not one of merely being unable to articulate a word currently held in consciousness. Instead, it was one of being fully aware of the target *idea* yet being totally unable to accomplish what normally feels like the single act of finding-and-saying-the-word (p. 49).

Anomia such as that described by Ashcraft (1993) results in impairment of word-finding while sparing comprehension. It is possible that, in the absence of being able to find the correct target word, anomics are still able to access and retrieve partial information associated with an irretrievable target. Furthermore, some theorists believe that anomia need not result in an absolute blockage of phonological information accompanied by spared semantic retrieval, but that partial phonological blockage is also possible (Kay & Ellis, 1987, Ashcraft, 1993). One view is that anomia may result from an interruption in the connectivity between the lexical

(conceptual) and phonological levels involved in language production (e.g. Caramazza, 1997; Levelt, Roelofs, & Meyer, 1999; Roelofs, 1997a, 1997b; Harley, 2008; Turken & Dronkers, 2011).

The fact that anomic aphasics are able to remember details associated with a target word even when they are unable to recollect the target word itself suggests that recollection may be variable. The hallmark frustration that is exhibited by anomic aphasics suggests that a signal indicating awareness of a target can occur despite an inability to convey an idea in verbal terms. This signal of awareness may represent a feeling of knowing (FOK) that a target is present despite being able to reach it. This may also be similar to a "feeling of warmth" experienced when an answer is impending (e.g., Metcalfe, 1986; Metcalfe & Wiebeb, 1987). This is also akin to the feeling experienced in tip-of-the-tongue states (see Schwartz, 2002 for a review). A tip-of-the-tongue state (TOT) is classically defined as an experience whereby "one cannot quite recall a familiar word but can recall words of similar form or meaning" (Brown & McNeill, 1966). A more modern definition of TOT offered by Schwartz (2002) is a "strong feeling that a target word, although currently unrecallable, is known and will (imminently) be recalled". Interestingly, anomic aphasics are a population with a very high rate of reported TOT experiences (Brown, 2012, Schwartz, 2010). Partial recollection, such as that in anomic aphasia, may serve to inform theories of the TOT phenomenon. Yet the theoretical relationship between partial recollection and TOT states is not well understood.

Chapter VI

Evidence from Tip-of-the-tongue States

A common occurrence associated with a TOT is retrieval and reportability of *some* aspect of a target in memory even when target retrieval fails. For instance, Brown and McNeill (1966) had participants study lists of 49 multisyllabic words of low frequency. At test, just the definition of each word was read. If the participants were unable to retrieve a studied word but felt as if they would eventually retrieve the answer (i.e., a TOT state) they were asked to indicate if they could retrieve the number of syllables, the initial letter, words of a similar sound, words of a similar meaning, or an alternative word that came to mind. Participants were then read the correct answer and asked to indicate whether it was their target word. Brown and McNeill found that TOT states were significantly correlated with the ability to report correct partial information associated with a desired target (e.g., phonologically and semantically similar words). TOT states have since been shown to be positively related to the retrieval of target attributes (e.g., the number of syllables, syllabic stress, the first letter, phonologically similar items, and semantically similar items) (see Brown, 1991; Schwartz, 2002 for reviews). Furthermore, some research has suggested that when phonological information is not available in a TOT state, syntactic information may be available (Lopez-Cutrin & Vigliocco, 2007; Vigliocco, Antonini, & Garrett, 1997; Vigliocco, Vinson, Martin, & Garrett, 1999).

In studies designed to elicit TOT states, partial retrieval is a common occurrence (Schwartz, 2002). One theoretical view is that TOTs arise from weak access to the actual representation of an item in memory resulting in recollection failure. According to this direct-access theory, activation of an item representation is below the threshold necessary for full retrieval but strong enough to elicit a subjective feeling that the item is retrievable (a TOT)

(Brown & McNeill, 1966, Perfect & Hanley, 1992; Schwartz, 1999). Although Brown & McNeill's original interpretation did not address the possibility of partial recollection in the absence of retrieval, more modern views do. Some have theorized that lexical access involves a two-step process whereby semantic representations are accessed prior to phonological representations (e.g., Bock, 1982; Gollan & Brown, 2006; Levelt, 1989; Miozzo & Caramazza, 1997a, 1997b). TOTs may result from semantic (i.e., partial) access to an item in the absence of phonological access (see also Levelt, Roelofs, & Meyer, 1999; Rapp & Goldrick, 2000). One form of the direct-access theory, known as the Transmission Deficit (TD) model, suggests that TOTs may result from a disruption in a relay of information from the level of lexical (semantic) representation to the level of phonological representation necessary for articulation (Burke, MacKay, Worthley, & Wade, 1991; James & Burke, 2000; Rastle & Burke, 1996; see Schwartz 2002 for a review).

However, other research has suggested that the direct-access approach may not be enough to explain the subjective feeling associated with TOT states (e.g., Cleary, 2006; Schwartz, 2008). Schwartz & Metcalfe (2011) have recently suggested that TOTs may also involve a "heuristic-metacognitive" component that integrates multiple forms of information including partial semantic, perceptual, phonemic, and syntactic information to create a summary signal of availability in memory. It is this summary availability signal that may give rise to the subjective feeling associated with a TOT, thus TOTs may serve an adaptive purpose in memory to spur further retrieval efforts if enough information is available (Schwartz & Metcalfe, 2011).

Chapter VII

Creating the Potential for Partial Recollection: Complexity

In the present study, I sought to understand what forms of information may facilitate partial retrieval. One possible form of information is the perceptual complexity of to-be-remembered targets. In a study designed to explore the degree to which partial information is recalled during TOT states, Schwartz & Smith (1997, Experiment 1) incrementally increased the complexity of information at study in an attempt to increase the likelihood that a TOT would occur. Participants studied lists of fictitious creatures accompanied by their country of origin (the minimum- information condition), their country of origin plus a picture of the creature, (the medium-information condition), or their country of origin plus a picture and a description of the creature (the maximum-information condition). At test, participants were cued with just the country name of a creature and asked to recall its name. If unable to do so, participants were asked to indicate whether or not they were in a TOT state, and then they were prompted to provide the first letter of the name or any other information that came to mind. Schwartz and Smith found that the likelihood of reporting a TOT state significantly increased between the low-information, the medium-information, and the maximum-information conditions. Additionally, the rate of retrieved partial recollection increased as a function of complexity, but recall rates and recognition performance did not increase. Schwartz and Smith's (1997) study is one of the first to explore the link between perceptual and semantic complexity of to-be-remembered items, TOT states, and partial recollection.

One of the keys to successfully isolating partial recollection may involve increasing the likelihood that it will occur (Parks, 2007; Parks et al., 2011). That is, it may be necessary to create complex information-rich episodes in order to increase the likelihood of partial

recollection. Additionally, simple word lists and source judgments involving item location or voice manipulations may not allow for high enough instances of partial recollection because they are not rich enough.

Parks, Murray, Elfman, & Yonelinas (2011) recently manipulated complexity within a source memory task in two different ways. Participants were required to remember either words (simple) or sentences (complex) that were either presented auditorily (simple) or audiovisually (complex). Participants also provided confidence ratings based on how likely they thought it was that they had made the correct source memory decision. Parks et al. found that a combination of simple source and simple item complexity led to the highest rate of recollection and the least reliance on familiarity. In a subsequent experiment, Parks et al. used a divided attention manipulation in healthy adults by having them perform the aforementioned source task while simultaneously performing a digit-monitoring task. Divided attention has been shown to reduce recollection while sparing familiarity (e.g., Gruppuso, Lindsay, & Kelley, 1997). Parks et al. hypothesized that if recollection contributed to both estimates in the simple and complex conditions, then divided attention should lead to a decrement in recollection performance for both. Indeed, such a decrement was seen. In a subsequent manipulation, amnesics demonstrated a similar decrement in the task. Parks et al. (2011) suggested that as stimulus complexity increases, the threshold for recollection breaks down. This breakdown results in a change in the nature of recollection such that it shifts from a threshold process to a more graded (i.e., continuous) process. This finding is important, because it suggests that the degree to which recognition memory depends on either recollection or familiarity may differ based on the complexity of a given task. Skinner and Fernandez (2010) also provided data suggesting that the complexity of contextual information at study can affect later recollection of target information

even when no contextual information is present at test. Skinner and Fernandez argue that such contextual information is bound to a target at study to create a rich “ensemble” in memory. This binding process in turn enhances memory by increasing the amount of information available at retrieval.

Chapter VIII

Additional Factors: Word Frequency and Emotionality

Word Frequency There may be other stimulus manipulations that could increase the amount of partial information available at retrieval. Such manipulations would allow for a way to observe changes in the behavior of partial recollection that may not occur in familiarity-based recognition. The first such manipulation is word frequency. Standard studies of word recognition are those in which studied items are repeated again during the test phase. In standard studies of word recognition, the word frequency effect (WFE) is the finding that low frequency (i.e., uncommon) words lead to higher hit rates and lower false alarms than high frequency (i.e., common) words (Brown, Lewis, & Monk, 1977; Gregg, 1976; Glanzer & Adams, 1985, Glanzer & Bowles 1976; Gorman 1961; Underwood & Freund, 1970). A likely reason for the WFE is that low frequency (LF) words are more distinct than high frequency (HF) words, and this leads to higher levels of recollection (e.g., Gardiner & Java, 1990 ; Guttentag & Carroll, 1997). In tests of recall however, previous research has shown a benefit for HF words over LF words (e.g. Clark & Burchett, 1994; DeLosh & McDaniel, 1996; Duncan, 1974; Gregg, 1976; MacLeod & Kampe; 1996, Mandler, 1980). One caveat to the HF advantage in recall is known as the mixed-list paradox. This paradox states that the benefit for HF over LF is eliminated or even reversed when low and high frequency items are intermixed within a list (e.g.,Watkins, LeCompte, & Kim, 2000; Morin et al., 2006). The mixed list paradox has typically been found in recall tasks demanding retrieval of order information (i.e., serial-recall).

If full and partial recollection respond similarly to manipulations in frequency, then that should provide important evidence that for a functional relationship between the two. However, the opposite pattern is also possible. That is, partial recollection may actually increase for LF

versus HF items. Previous research has suggested that LF words are more likely than HF words to produce TOT states (e.g., Burke, MacKay, Worthley, & Wade, 1991). If this second possibility holds true, then manipulation of word frequency as an independent variable should affect full recollection differently than partial recollection. In the next section I discuss manipulation of another variable, emotionality, which may also modulate partial recollection.

Emotionality The relationship between emotion and memory is an old yet poorly understood one. A great deal of data suggests that emotion can alter and even enhance recall (e.g. Christiansen 1992; Heuer & Reisberg, 1990; Reisberg & Hertel, 2004). However, far less is known about how emotion impacts recognition memory. When we retrieve a remote memory from the past, we bring to mind not just one aspect of the event, but we retrieve an episode rich in contextual detail (Sharot & Yonelinas, 2008; Tulving, 1985). Kensinger (2009) argued that both cue familiarity (e.g., Metcalfe, 1993; Metcalfe, Schwartz, & Joaquim, 1993) and partially retrieved information (e.g., Koriat & Levy-Sadot, 2003; Schwartz & Smith, 1997) can impact judgments of emotional memory. Importantly, she argued that familiarity and partial retrieval are separate entities, and that emotion can have an impact on each. She hypothesized that emotion should enhance both cue familiarity and partial information, but that the source of this enhancement is different. In particular, Kensinger proposed that "because negative emotion enhances memory for some details, participants should be more likely to remember some details of an emotional item's presentation than of a neutral item's presentation."(p. 14). She also argues that "this partial recollection may lead participants to believe that they will be able to remember other details of an emotional item's presentation" (p. 14). According to this hypothesis, enhanced cue familiarity, which is a reliance on inherent familiarity of a test item to predict later memory performance, should manifest as a bias for emotional versus nonemotional events in the absence

of being able to generate any information about the event. That is, if a test cue is emotional in nature, an individual may be prone to rate their confidence that related information will be remembered higher than if a test cue is emotionally neutral. In contrast, an effect of emotion on partial information should lead to both a quantifiable increase in generated partial details as well as a bias in confidence for those events.

Some studies have indicated that in the absence of being able to recall a word, individuals are still able to access partial information such as the affective nature of a target (Koriat, Levy-Sadot, Eyal, & de Marcas, 2003). One such study links emotion and partial recollection to the TOT literature. Schwartz (2010) had participants study lists of neutral one-word target answers interleaved with emotional target words answers. Participants then viewed general knowledge questions pertaining to neutral or emotional targets. They were given the definition of a TOT as "the feeling that you know the target and will recall it soon" (p. 83) and they were either encouraged to answer the question or respond "don't know". In the event they responded "don't know", participants were asked to indicate whether they were in a TOT state or not and then they rated the emotionality and degree of frustration they had with the answer. Finally, participants were given a four-alternative forced choice recognition test for the answers. Schwartz found that individuals experienced a higher rate of TOTs for unanswered emotional versus unanswered neutral questions. He also found that the emotional ratings of the TOT experiences were higher for questions pertaining to emotional questions than for answers pertaining to neutral ones. Schwartz concluded that manipulation of emotion significantly impacted the likelihood of TOTs. One possibility is that partial emotional details retrieved in the absence of target retrieval serve as a basis for higher TOTs than partial neutral details. Therefore, if higher stimulus emotionality

leads to higher TOTs, and if TOTs are highly associated with retrieval of partial details, then stimulus emotionality should also lead to higher objective levels of partial recollection.

In studies of emotion, stimuli can differ on two primary emotional dimensions: valence and arousal (Lang, Bradley, & Cuthbert, 1990). Valence is the degree to which a stimulus is positive or negative in nature, and arousal is the degree to which a stimulus is exciting or calming. Though it is important to determine the individual contributions of any variable to a process in memory, it may actually be an interaction between valence and arousal that impacts memory the most. Mickley-Steinmetz, Addis, and Kensinger (2010) found that recognition memory performance was enhanced for negative arousing pictures compared to positive arousing pictures. There is growing consensus in the recognition memory literature that negative valence and high arousal both lead to increased recollection (e.g. Dewhurst & Parry, 2000; Ochsner, 2000; Sharot, Delgado & Phelps, 2004; Sharot, Verfeille, & Yonelinas, 2007; Kensinger & Corkin, 2003; but see Dougal & Rotello, 2007).

Some research from our laboratory indicates that both valence and arousal may affect recollection but not familiarity in the absence of recollection when emotionality is not inherently present in the test cues (i.e, the word "*suicide*" is inherently emotional, but the similar nonword cue "*surctitide"* is not). Using the recognition without cued-recall method, or RWCR, Ryals and Cleary (2012, Experiment 2) had participants study lists of highly-arousing, negatively-valenced, or neutral words. At test, participants then viewed twice as many non-word cues, half of which were created to orthographically and phonologically resemble studied items, and half of which were new. Participants indicated whether or not they could identify a studied item that resembled a given test cue, and then they rated the likelihood that the cue resembled a studied item on a 0-10 scale. Ryals and Cleary found that non-word cues corresponding to both high-arousal and

negatively-valenced words elicited significantly higher cued recall rates than non-word cues corresponding to neutral words. Arousal (but not valence) was also found to bias recognition ratings given in the presence of cued recall, such that participants rated both correctly recalled and correctly guessed items as higher if the generated information was arousing in nature. Ryals and Cleary found no effect of emotion on familiarity-based recognition ratings in the absence of cued recall, yet participants could still reliably discriminate cues resembling old from new items even when they couldn't recall them. Their finding suggests that emotionality presented at study but not reinstated at test is a variable that differentially affects recollection and familiarity in the absence of recollection.

Manipulating the effects of valence and arousal as separate dimensions may not be the best approach to understanding how emotion operates in memory. Rather, it may be that capitalizing on an interaction of the two dimensions of emotion may maximize the likelihood of its effects. Prior research from our laboratory (Ryals & Cleary, 2012) suggests both valence and arousal impact recollection, and that when test cues themselves are not emotional in nature, no effect of emotion on familiarity is found.

Chapter IX

The Recognition without Identification (RWI) Method

Recognition without Identification (RWI is the finding that, even in the absence of successful identification (i.e., recollection), individuals can still demonstrate the ability to distinguish studied from nonstudied items through ratings of familiarity. For instance, using the recognition without identification paradigm (RWI), Cleary and Greene (2000) provided evidence that even when recollection of a studied item fails, subjects were still able to distinguish studied from nonstudied fragments at test by using familiarity ratings. This RWI method and the related recognition without cued-recall method (RWCR) have been replicated using numerous manipulations and extended across multiple stimulus domains in separate laboratories (e.g., Arndt, Lee, & Flora, 2008; Cleary, 2004; Cleary & Greene, 2000; 2005; Cleary, Langley, & Seiler, 2004; Cleary, Ryals, & Nomi, 2009; Cleary & Specker, 2007; Cleary, Winfield, & Kostic, 2007; Cotel, Gallo, & Seamon, 2008; Kostic & Cleary, 2009; Peynircioğlu, 1990).

One modified form of the RWI, used by Cleary (2006), provides an intersection between experimental frameworks used in TOT research with those used in studies of metacognition and recognition memory. This particular variant of RWI may prove especially usefully for separating full target recollection from partial recollection and instances of recollection failure. Cleary (2006) had participants study lists of answers to general knowledge questions (e.g. *MERCURY*). At test, they were presented with twice as many questions. Half of the answers to the test questions had been studied (e.g., *what is the only metal that is a liquid at room temperature?),* and half of the answers had not been studied. Participants were asked to try and recall the answer to a given question and then to rate the likelihood that they had studied the answer using a 0-10 scale. In Experiment 1, Cleary found that having studied an answer increased the likelihood of

correctly answering it. Even when they could not provide the answer to a test question, participants were able to reliably discriminate between questions whose answers had been studied from those whose answers had not been studied (the RWI effect). In Experiment 2, if a participant failed to correctly identify an answer, he or she was asked to indicate whether they were in a TOT state. Cleary once again found an RWI effect when identification failed. Additionally, she found that individuals gave higher ratings of familiarity when in a TOT state than not in a TOT state. Perhaps most interesting, old-new discrimination in the absence of identification was significantly better when individuals were in a TOT state than when they were not in a TOT state. In Experiment 3, participants were asked to provide any partial information in the event that they could not identify the answer to a question (i.e., the first or last letter, a similar sounding word or phrase, the number of syllables, or any other information). Cleary found that, once instances of partial recollection were removed from the data pool, the RWI effect persisted, and she found that being in a TOT state is not a necessary condition for the RWI effect to occur. Rather than relying on perceptual hindrance from study to test, Cleary (2006) capitalized on existing semantic representations in memory.

In a study using a similar method with scene stimuli, Cleary & Reyes (2009) first presented participants with lists of names of famous locations (e.g., *the Louvre*). At test, participants viewed lists of color scenes, half of which corresponded to studied names and half of which did not. In Experiment 1, participants were first asked to identify the name of a given test scene and then to rate the likelihood that they had studied the scene's name using a 0-10 confidence scale. For Experiment 2, in the event that a participant was unable to identify a given scene, Cleary & Reyes had participants indicate if they could retrieve any partial information about a scene's name. Finally participants were asked whether they were in a TOT state for each

test scene that failed to elicit identification. An RWI effect was found, such that even when unable to recall the name of a famous scene, participants could still reliably discriminate studied from nonstudied scene names through ratings of familiarity. This effect persisted even after instances of partial recollection had been removed from the pool of data. When identification failed, participants also gave higher ratings when in a TOT state than when not. Unlike Cleary & Specker (2007) however, the RWI effect remained even in non-TOT states.

All three of the studies using this particular version of the RWI paradigm (Cleary, 2006; Cleary & Specker, 2007; Cleary & Reyes, 2009) capitalized on existing knowledge representations in memory. The fact that a participant was able to recall a name in response to a famous face suggested that a preexperimental association existed between the two (Cleary & Reyes, 2009). Though being able to correctly articulate the information necessary for a correct identification of a test cue involves both lexical and phonological representations, the ability to discriminate old from new answers in the absence of identification is believed to involve only information on the lexical level. Cleary (2006) and Cleary & Reyes (2009) proposed that the RWI effect may be due an ability to detect either the level of baseline activation of a representation or its recency in memory. That is, the more recently an item has been experienced (i.e., primed), the more likely it is to be detected in contrast to other items within a representational network, even when the item cannot be recollected.

This particular variant of the RWI paradigm offers several advantages for studying the underlying mechanisms of recognition memory. First, this method allows for an objective index of full target recollection, partial recollection, recognition that accompanies such types of recollection (full vs. partial), as well as familiarity that occurs in the absence of any recollection. Perhaps most importantly, the method provides a means of eliciting partial recollection that

occurs when full target recollection fails. In Cleary (2006) and Cleary and Reyes (2009), instances of partial recollection did indeed occur. Interestingly, both of these studies indicated that partial recollection is more likely in response to nonstudied items than to studied items. That is, even when unable to provide the answer to a general knowledge question, participants were sometimes able to provide partial information occurring below the threshold of target identification, and these instances were more likely in response to nonstudied rather than studied target answers. One potential explanation for this is that the more recently an item has been experienced, the higher its level of activation is, and subsequently its likelihood of being retrieved is also higher. Conversely, nonstudied answers which have not been recently experienced may lead to an increased likelihood of partial recollection. This view is consistent with the TD model in TOT research (Burke et al., 1991; Rastle & Burke, 1996). Whereas instances of partial recollection were ultimately separated and discarded from the analyses in Cleary (2006) and Cleary & Reyes (2009), retaining and capitalizing on these instances may provide important insights into the nature of partial recollection.

Chapter X

The Present Study

The present study contains three experiments in which I manipulated perceptual complexity, word frequency, and word emotionality of target words. The purpose of these manipulations was to gauge whether or not stimulus manipulations that have been shown to modulate recollection would also modulate partial recollection differently than recognition occurring in the absence of recollection. Whereas many of the previous studies concerning partial information in memory have used source memory tasks, the paradigm in the present study offers a more practical approach than both source memory tasks and traditional methods such as PDP and RK. If partial recollection is fundamentally different than familiarity, it should respond to experimental manipulations that affect recollection itself and recognition *with* recollection but these manipulations should have a different effect on recognition that occurs in the absence of recollection (RWI). The primary purpose of Experiment 1 was to explore the hypothesis proposed by Parks' (2007) and Parks et al. (2011) that systematically increasing the perceptual complexity of a target at encoding increases the likelihood that partial recollection of that target would occur at retrieval. Also, of interest in Experiment 1 was the degree to which increased complexity through presentation of additional information at encoding can increase later full or partial recollection when that information is not presented at test (e.g., Skinner & Fernandez, 2010).

The primary purpose of Experiment 2 was to manipulate target word frequency in order to examine whether partial recollection is more likely in high or low frequency situations. Given that prior research suggests partial recollection may be distinct from full target recollection, Experiment 2 examined whether full and partial recollection differs in response to a word

frequency manipulation. Though full target retrieval should benefit from high word frequency of the target word, it was unclear whether partial recollection would show the same benefit. For example, TOT experiences are more likely for low than high frequency words, suggesting that partial retrieval may actually be more likely for low frequency words (e.g. Cleary, 2006). A secondary purpose of Experiment 2 was to manipulate list type to determine if the mixed list paradox for word frequency impacts levels of full and partial recollection in this version of the RWI paradigm (e.g., Morin et al., 2006). Specifically, I sought to understand if a mixed or blocked study list differentially affects retrieval (both full and partial). The primary purpose of Experiment 3 was to manipulate the emotionality of studied items to test the hypothesis that combining negative valence with high arousal leads to a greater likelihood of partial recollection than emotionally neutral items as Kensinger (2009) and Mickley-Steinmetz and Kensinger (2010) have suggested.

Chapter XI

Experiment 1

Experiment 1 examined the degree to which increased stimulus complexity affects the likelihood of full target recollection, the likelihood of retrieving partial information that accompanies full target recollection, and the likelihood of partial recollection when full target recollection fails. By systematically manipulating the number of perceptual contextual details at encoding, I sought to manipulate the likelihood that partial recollection would occur. There were five primary hypotheses in this experiment. The first hypothesis was that the rate of full target recollection would differ as a function of stimulus complexity such that the higher the complexity at encoding the higher the proportion of full target recollection. The second hypothesis was that the rate of partially-recollected items would also increase with the degree of increased stimulus complexity. Next, I hypothesized that when individuals failed to retrieve any information about targets, they would still be able to discriminate between questions related to targets that did appear at study from those that did not (the RWI effect). The fourth hypothesis was that ratings in the presence of partial recollection would follow a graded pattern; the highest ratings will correspond to partially recollected items encoded with the highest degree of complexity, and the lowest ratings will correspond to items encoded with the lowest degree of complexity. The fifth hypothesis is that ratings given in the presence of full target recollection would also follow a graded pattern based on the level of complexity, and that these ratings would differ from those given in the presence of partial recollection and RWI.

Method

Participants. Participants were 98 undergraduate students from Colorado State University who participated for partial completion of a course requirement. Six individuals were excluded from data analysis due to a failure to follow instructions resulting in a final sample of 92.

Materials. Materials were 120 general knowledge questions and one-word target answers taken from the Nelson & Narens (1980) norms (see Appendix A).[1] The lexical characteristics for word target stimuli, as determined by the English Lexicon Project (Balota et al., 2007) are listed in Table 1. The order of study-test presentation and complexity-target paring was counterbalanced across six experiment versions. Item order selection within-participant was fully randomized.

Table 1.
Lexical Characteristics of Target Words from Experiment 1.

	Mean	(SD)
Log HAL Frequency	7.01	1.52
Length (number letters)	6.80	1.57
Syllables	2.33	0.71
Orthographic_N	1.42	2.68
Phonographic_N	3.09	5.59

[1]A separate norming experiment was conducted to determine the correct identification rate of the general knowledge questions used in Experiment 1 and Experiment 2. Sixty-eight participants viewed all 112 general knowledge questions from the Nelson and Narens (1980) norms in four separate blocks. Order of item presentation was randomized within each block. Participants were asked to answer the question when it appeared on the screen, and then they

were asked to rate the difficulty of the question on a scale of 1-10 (1= extremely easy, 10= extremely difficult). Participants answered an average of 40% of the questions correctly (*M*=.40, *SD*=.12). Participants also rated the difficulty of the questions that were correctly identified at a level of 5.26/10 (*SD*=2.70), and they rated the difficulty of those that they did not identify at a level of 5.60/10 (*SD*=2.29). At least one correct response was recorded for each of the 112 questions.

Procedure. All stimuli were presented visually using E-Prime software (Psychology Software Tools, Pittsburgh, PA) on Dell PCs in our laboratory. After signing consent forms detailing the nature of the experiment, participants were read instructions on the computer screen prior to beginning the experiment. During the study phase, each participant was presented with an initial fixation cross for 1 sec. Next they viewed one-word target answers presented in 30 point Arial Font in the center of the screen for 2 sec each with an interstimulus interval of 1 sec. Each study word fell into one of three possible complexity conditions. In the first condition (level 1) the study word target was presented alone in black 30 pt. font on a plain white screen. In the second condition (level 2) the study word target appeared in black font on a colored background (e.g., red, green, blue, yellow, orange). For the third condition, (level 3) the study word target appeared in black font on a colored background (e.g., red, green, blue, yellow, orange) within a particular color-filled shape (e.g. a circle, triangle, diamond, pentagon, or an octagon). Participants were simply told that they were to remember the words for a later memory test. They were also told that one strategy to help remember the words is to associate any available information with the target. For each study block, participants viewed 15 target words (five from level 1, five from level 2, and five from level 3). The order of presentation within each block was randomized. Following from Cleary (2006), after viewing each study list, participants were given the following instructions for the test phase:

> Now you will be presented with a list of general knowledge questions. For each item on the test, you will first be presented with a question and asked if you can

answer it. If you can answer it, simply type the answer. Next, you will be asked to decide if you think that the answer to the question appeared in the study list or not. You will do this by providing a rating on a scale of 0-10 (0=sure the word was not studied, 10=sure the word was studied). Next you will be asked to provide any partial information about the answer from the study phase. If you were unable to identify the answer, please type any partial information that comes to mind (e.g., a similar sounding word, the first letter of the answer, the number of syllables, background color, or background shape). If you were initally able to identify the answer to the test question, simply press ENTER to move on to the next test item. Even if you cannot identify an answer, we want you to provide a rating of the likelihood that you studied an answer for each item prior to providing any partial information that may come to mind.

Each trial automatically advanced after 10 sec. Each test block consisted of five questions corresponding to level 1 targets, five questions corresponding to level 2 targets, five questions corresponding to level 3 targets, and 15 new questions. This procedure was repeated across four study-test blocks Spelling of responses was checked offline and items were coded by hand to determine category membership (i.e., full target recollection, partial target recollection, failed recollection, or new).

Results and Discussion

Full Target Retrieval

For this experiment, an alpha significance criterion of $p < .05$ was set and effect sizes are reported. The first analysis addresses the likelihood of full target retrieval as a function of stimulus complexity. That is, how often did participants actually retrieve the target answer in

response to the question in each condition? These data are displayed in Table 2 and Figure 1. Because the test items consisted of general semantic knowledge questions, it was possible that participants could successfully retrieve a non-studied target in addition to retrieving studied targets. For example, if "Toto" was not a studied word, some participants might still retrieve "Toto" in response to the question, "What was the name of the dog in the Wizard of Oz?" A one-way repeated-measures ANOVA was conducted on the proportions of full target recollections across levels of stimulus complexity (new, Level 1, Level 2, and Level 3). An effect of stimulus complexity was found [$F(3,273)= 45.27$, $MSE=.01$, $p<.001$, $p\eta^2 =.33$]. Bonferroni post-hoc comparisons indicated that questions corresponding to Level 1 targets elicited a higher level of full target retrieval than those corresponding to Level 2 targets ($p=.001$). Questions corresponding to Level 1 targets were also retrieved at a higher rate than Level 3 targets ($p=.001$). Ratings did not differ between Level 2 and Level 3 ($p=.74$). Finally questions corresponding to Levels 1, 2, and 3 all elicited a higher degree of full retrieval than those corresponding to unstudied targets (all ps <.001).

Table 2. Mean Proportion of Full Retrieval for Studied Targets By Complexity Level for Experiment 1.

(Complexity Level)	Mean	(SD)
Nonstudied	.37	*(.14)*
Level 1	.58	*(.17)*
Level 2	.50	*(.20)*
Level 3	.50	*(.17)*

The finding that full retrieval was reliably higher for Level 1 targets than for both Level 2 and Level 3 targets is inconsistent with my first hypothesis. This suggests that, contrary to my predictions, increasing target complexity at encoding in the present study does not increase the likelihood of later full target recollection incrementally. One potential reason for this is that pairing contextual information with targets (i.e., colors and shapes) drew attention away from the encoding of the target itself. That is, retrieval of Level 1 targets may have been higher because participants were able to devote attention to the targets themselves rather than having to divide finite visual attention resources between the target and additional information (e.g., Wickens, 2002).

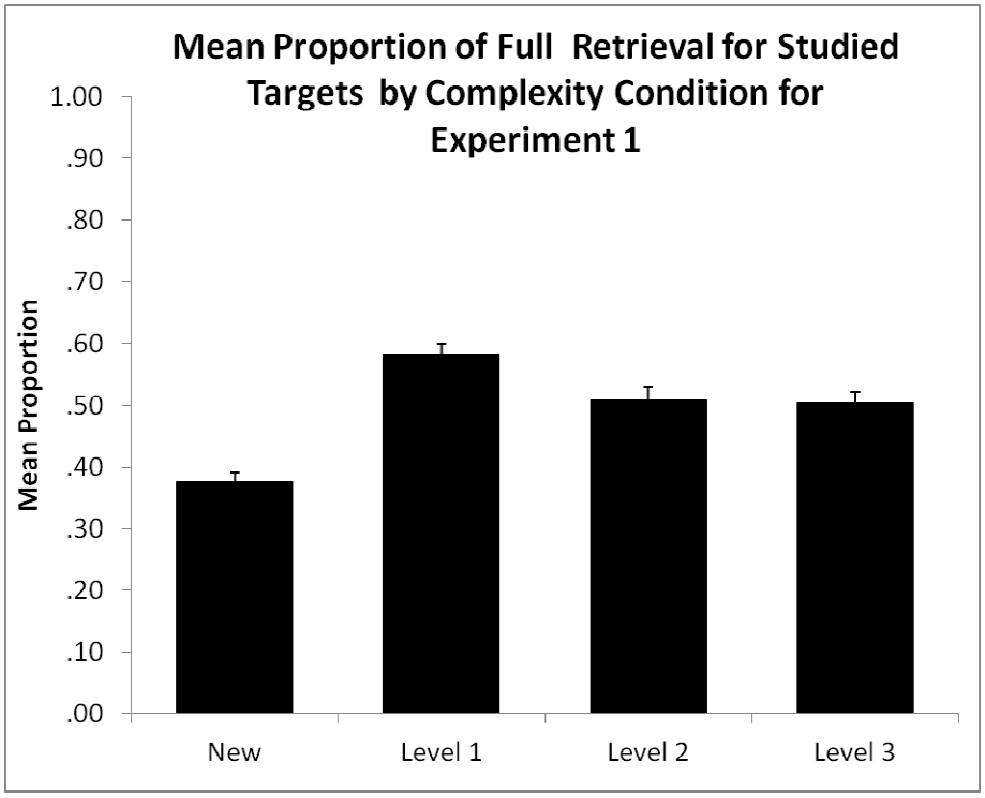

Figure 1. The mean proportion of full target recollection per complexity condition in Experiment 1.

Partial Target Recollection when Full Target Retrieval Failed

For this experiment, partial target recollection was operationally defined as any instance of correct identification of target-related information (the first letter, last letter, number of syllables, a similar-sounding word, a rhyming word) that occurred 1) upon being prompted for partial information and 2) when full target recollection failed.[2] These data are presented in Table 3 and in Figure 2 as a function of context complexity level. A one-way repeated measures ANOVA did not reveal a significant effect of Complexity Level (non-studied, Level 1, Level 2, Level 3), (F=1, p=.40*).* No significant differences were found between the level of partial retrieval of target-related information for questions corresponding to Level 1-3 targets or those corresponding to nonstudied targets. In short, not only did context complexity level not affect the likelihood of partial target recollection, but neither did merely studying an item, as nonstudied items were no more or less likely to be partially recollected than studied items. This suggests that partial target recollection may not be influenced by external manipulation of contextual complexity. This is counter to my hypothesis and the complexity hypothesis proposed by Parks (2007) and Parks et al., (2011).

[2] In addition to correct partial information that occurred upon prompting after the identification attempt, incorrect identifications provided on the identification attempt itself sometimes contained correct partial information. For example, if the to-be-retrieved low frequency target was "*Euclid"*, a participant may have provided the answer "*Einstein"* instead. Although the two are notably different historical figures, their names possess the same first letter "*E"* and the same number of syllables (two). Because such information was provided on the identification attempt itself rather than upon being explicitly prompted for partial information, participants may not have been aware that their identification attempts in these instances were incorrect or that they contained correct partial information. Thus, such instances might be labeled incidental partial retrieval. Although not central to the study at hand, such incidental partial retrieval instances may be theoretically interesting in and of themselves. Retrieval rates and recognition ratings for such instances of incidental retrieval in Experiment 1 can be found in Appendix B.

Table 3. Mean Proportion of Partial Target-Related Retrieval by Complexity when Full Retrieval Fails in Experiment 1.

(Complexity Level)	Mean	(SD)
New (nonstudied)	.003	*(.01)*
Level 1	.005	*(.02)*
Level 2	.002	*(.01)*
Level 3	.004	*(.01)*

It is noteworthy that the partial target recollection rates are quite low across all conditions. This suggests that partial recollection of unretrieved studied words' information in list-learning paradigms may actually be quite rare. It may be that traditional list-learning paradigms with word stimuli are not the best means for tapping target-related partial information. This is potentially theoretically important because a current controversy in the recognition memory literature concerns whether measures of familiarity actually tap partial recollection instead of familiarity (e.g., Mickes, Wixted, & Wais, 2007). If indeed list-learning paradigms are not an effective means of tapping partial recollection, then an implication might be that partial recollection contributes minimally in these paradigms, in which case, dual-process models that assume that recognition decisions come about primarily through either full target episode recollection or familiarity may be reasonably adequate for describing data from these paradigms. This does raise the question, to what degree does partial recollection occur in day-to-day life, and what laboratory paradigm might best probe such experiences?

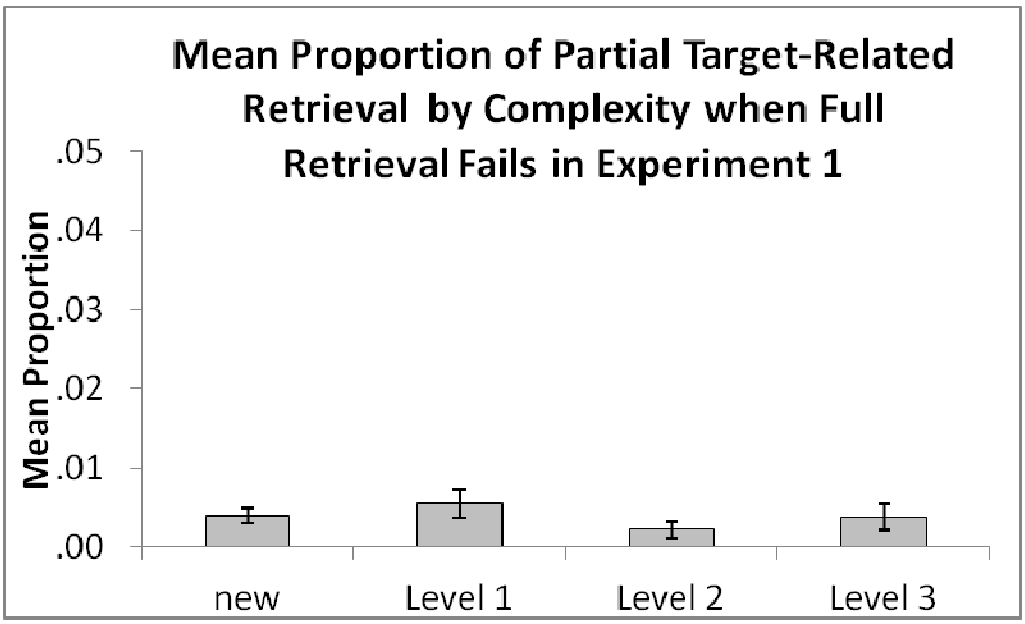

Figure 2. Mean Proportion of Partial Target-Related Retrieval by Complexity when Full Retrieval Fails in Experiment 1.

Context Recollection

Another type of partial retrieval to consider is contextual information (i.e., perceptual information that was paired with a target at encoding, such as background color, or the background shape) for both studied targets which were fully retrieved and studied targets for which retrieval failed. It is important to note that in this experiment, context information can be retrieved in the presence of successful target recollection and in the absence of target recollection. These data are displayed in Table 4 and Figure 3. To examine whether retrieval of context information was more likely when the target itself was retrieved than when it was not, a 2 x 2 Retrieval Status (Full Retrieval, Partial Retrieval) X Complexity Level (Level 1, Level 2, Level 3) repeated measures ANOVA was conducted. No Retrieval X Complexity interaction emerged [$F(2,182)=.08, MSE=.02, p=.92, p\eta^2=.001$]. However, a significant a main effect of Retrieval Status was found, [$F(1,91)=117.00, MSE=.02, p<.001, p\eta^2=.56$] such that more context recollection occurred for retrieved than for unretrieved targets. As can be seen in Table 4

and Figure3, the amount of contextual information available at encoding had very little effect on the ability to retrieve context information; no main effect of Complexity Level was found [$F(2,182)=.19, MSE=.01, p=.82, p\eta^2=.002$].

These results suggest that, like partial target recollection, systematically manipulating stimulus complexity at encoding had little if any effect on the likelihood of contextual partial retrieval when full retrieval of a studied target failed. Perhaps the contextual information accompanying fully retrieved targets was encoded to a higher degree (i.e., unitized) than that for targets which were not fully retrieved. Items were only presented once at encoding in Experiment 1.

Table 4. Mean Proportion of Contextual Retrieval for Studied Targets by Retrieval Status and Complexity in Experiment 1.

	Studied Retrieved		Studied Unretrieved	
(Complexity Level)	Mean	(SD)	Mean	(SD)
Level 1	.14	*(.15)*	.01	*(.02)*
Level 2	.14	*(.16)*	.01	*(.02)*
Level 3	.15	*(.16)*	.01	*(.03)*

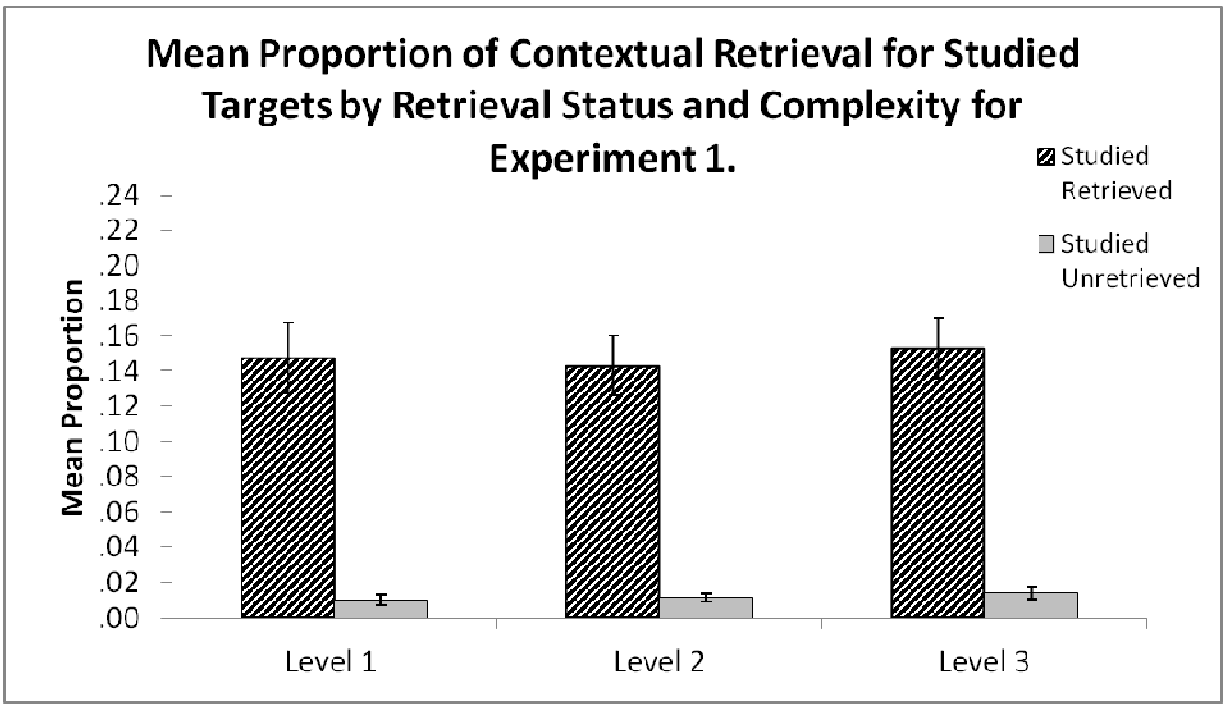

Figure 3. Mean Proportion of Contextual Retrieval for Studied Targets by Retrieval Status and Complexity in Experiment 1.

It is possible that multiple encoding sessions are required to bind contextual information to targets as Cook, Marsh, and Hicks (2006) suggested. Interestingly it was mainly when individuals were able to fully retrieve a studied target that they were able to generate associated contextual details. This suggests that perhaps context recollection typically only occurs when the target item itself is recollected; that is, perhaps people tend to recall an entire episode as an ensemble more often than they recall only bits and pieces of an episode.

Even when full target recollection occurred, the likelihood of partial contextual retrieval did not differ as a function of stimulus complexity. This is also in opposition to the complexity hypothesis (Parks, 2007; Parks et al., 2011). This may mean that the hypothesis is not empirically supported; perhaps the likelihood of partial contextual retrieval simply does not differ as a function of stimulus complexity. Alternatively, perhaps the simple type of perceptual

information used in Experiment 1 (colors and shapes) may have not been substantial enough to create a "rich ensemble" in memory that reflects the complexity of real-world memories.

Another noteworthy aspect of these results concerns the very low levels of context recall that occurred when target retrieval failed. This suggests that perhaps when retrieval of a studied word fails, recollection of the context in which that word was presented is extremely unlikely. This has implications for current debates in the recognition memory literature with regard to whether recollection is an all-or-none process or a variable (some-or-none) process. The current results are somewhat consistent with a threshold account of recollection (e.g., Parks & Yonelinas, 2007). In the complexity hypothesis, Parks et al. (2011) proposed that as the complexity of a stimulus increases, the threshold for recollection breaks down. The present results suggest that this may not be true. Another possibility is that the stimulus complexity in Experiment 1 was not great enough to cause the threshold of recollection to weaken in order for recollection to become variable.

Recognition Ratings Given in the Presence of Full Target Retrieval

To examine recognition ratings given in the presence of full target retrieval, a one-way repeated measures ANOVA was conducted across levels of stimulus complexity (New, Level 1, Level 2, Level 3). These data are displayed in Table 5 and in Figure 4. A main effect of Complexity Level was found, [$F(3,270)=491.22$, $MSE=1.34$, $p<.001$, $p\eta^2=.85$]. Bonferroni post-hoc tests confirmed that ratings given to Level 1 targets were higher than nonstudied targets ($p<.001$), that Level 2 targets were higher than nonstudied targets, ($p=.03$), and that Level 3 targets were higher than nonstudied targets ($p=.02$). Bonferroni post-hoc tests also confirmed that ratings did not differ between Level 1 and Level 2 ($p=.32$), between Level 2 and Level 3 ($p=.91$), or between Level 1 and Level 3 ($p=.25$).

Table 5. Mean Recognition Ratings For Fully Retrieved Targets by Complexity Level in Experiment 1.

(Complexity Level)	Mean (*SD*)
New (Nonstudied)	3.08 *(1.84)*
Level 1	8.53 *(1.65)*
Level 2	8.47 *(1.67)*
Level 3	8.64 *(1.59)*

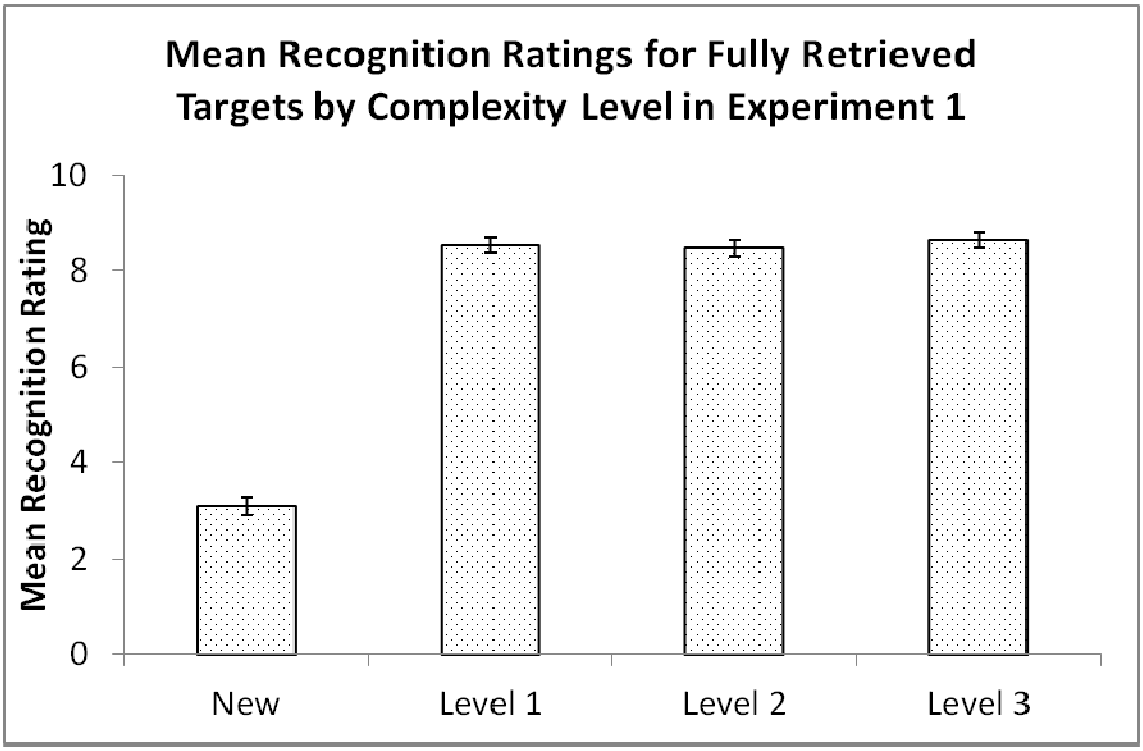

Figure 4. Mean Recognition Ratings for Fully Retrieved Targets by Complexity in Experiment 1.

Recognition Ratings Given When All Forms of Retrieval Failed

Recognition ratings given when all forms of retrieval failed are displayed in Table 6 and in Figure 5. These are ratings for trials on which no recollection (e.g., full target, partial target, or context information) occurred. A one-way repeated measures ANOVA was first conducted to compare ratings given to questions corresponding to studied targets across levels of complexity. This test did not reveal a significant main effect of Complexity Level ($F<1$). Next, a series of three planned paired-samples t-tests were run to compare recognition ratings corresponding to studied targets in the absence of any retrieval to recognition ratings corresponding to nonstudied targets. The first test revealed that, in the absence of any retrieval, ratings given to questions corresponding to Level 1 studied targets were significantly higher than those given to questions corresponding to nonstudied targets [$t(91)=14.30$, $p<.001$, Cohen's $d=2.81$]. Similarly, ratings given to questions corresponding to Level 2 studied targets were higher than those given to questions corresponding to nonstudied targets [$t(91)=2.30$, $p=.03$, Cohen's $d=.40$]. Finally, ratings given to questions corresponding to Level 3 targets were also higher than those given to questions corresponding to nonstudied targets [$t(91)=2.23$, $p=.03$, Cohen's $d=.37$].

Table 6. Mean Recognition Ratings when all Retrieval Fails (The RWI Effect) for Experiment 1.

(Complexity Level)	Mean (*SD*)
New (Nonstudied)	3.14 *(1.23)*
Level 1	3.68 *(1.49)*
Level 2	3.50 *(1.71)*
Level 3	3.49 *(1.65)*

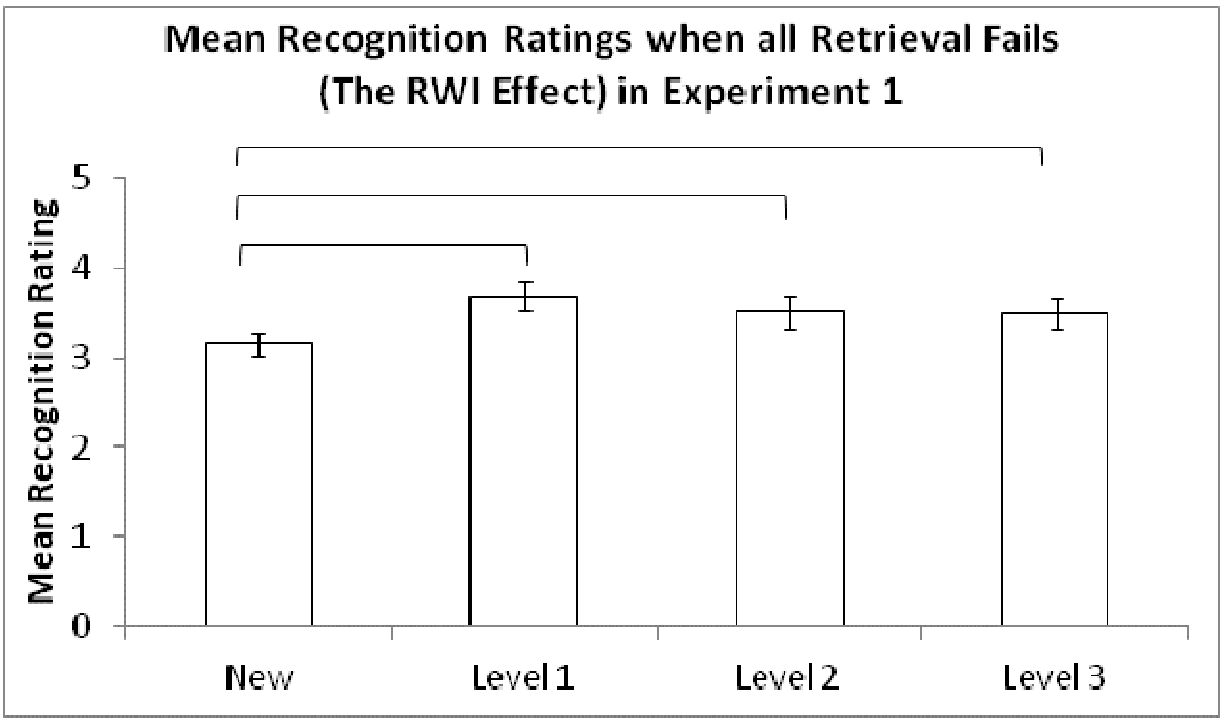

Figure 5. Mean Recognition Ratings when all Retrieval Fails (The RWI Effect) for Experiment 1

These findings reveal the presence of an RWI effect: participants could discriminate between questions related to studied targets from those related to nonstudied items even in the absence of being able to retrieve any information about the targets. However, level of stimulus complexity did not significantly impact the magnitude of the RWI effect.

Recognition Ratings Given In the Presence of Only Partial Recollection

While it might be of interest to examine ratings in the presence of only partial recollection (i.e., correct partial target information or correct context information), the low number of instances of partial retrieval make it difficult to meaningfully interpret these data. Many subjects did not have even one instance of partial recollection for a given stimulus level in the studied category for contextual partial information (55 subjects in Level 1, 56 in Level 2, and 51 in Level 3 had no instances). Even more participants had no instances of partial target recollection (83 subjects in Level 1, 88 in Level 2, and 86 in Level 3 had no instances). Beyond

the extreme loss of subjects in trying to compare ratings in this category, there is the concern that very few such instances occurred even among those subjects who had at least one instance of partial recollection in each category, thus leading to a low number of items contributing to each mean. For these reasons, these data have been relegated to Appendix C for the reader's reference.

The low occurrence of partial recollection may in itself be theoretically meaningful. If many individuals experience very few instances of partial retrieval on a regular basis, comparing this to rates of full recollection suggests that the two may be distinctly different. If every participant is able to demonstrate full retrieval, then why do so few demonstrate partial retrieval in the same experiment if recollection is all one continuous process? One may take this as evidence that recollection really is governed by an all-or-none threshold mechanism as some theorists claim. However, this does not account for the fact that individuals *do* sometimes have partial information available to them.

If partial retrieval did not respond to a systematic manipulation in perceptual complexity, then what other factors might be used to manipulate it? One possibility is factors involved in conceptual (i.e., semantic) complexity of the stimuli themselves. For example, pairing a target answer with a colored shape at encoding necessitated binding of contextual details to the target, but perhaps manipulating stimulus characteristics that are presumably already present in memory will tap partial recollection in a more direct way. Word frequency is one possible conceptual factor. The next experiment will examine whether manipulating word frequency of target answer will affect partial recollection.

Chapter XII

Experiment 2

The purpose of Experiment 2 was to determine whether word frequency is a factor that would affect full target recollection in a manner similar to partial recollection but differently than recognition that occurs in the absence of recollection. Previous research has suggested that high frequency (HF) words offer an advantage over low frequency (LF) words in recall-based memory by increasing retrieval accessibility (e.g. Gregg, 1976). Conversely, LF words have been shown to induce higher rates of TOT states compared to HF words (e.g., Burke et al., 1991). If word frequency affects full target recollection in a manner similar to partial target recollection, then manipulating word frequency should provide evidence that the two are functionally similar. However, the opposite pattern is possible. If HF increases full target recollection, and TOT states are more likely for LF words, then LF may increase the likelihood of partial recollection, thus providing evidence for a functional dissociation between the two.

There were four primary hypotheses in the present experiment. The first hypothesis was that HF words will lead to an increase in the proportion of full target recollections compared to LF words. The second hypothesis was that LF words would increase the proportion of partial retrieval compared to HF words, assuming that word frequency has opposing effects on full versus partial target recollection. The third hypothesis was that list presentation type would affect the likelihood that HF words would actually increase the magnitude of the RWI effect compared to LF words. Given the mixed list paradox for word frequency in standard list-learning paradigms (e.g., Morin et al., 2006), it is possible that HF words would lead to a greater RWI effect compared to LF words when a pure list format is used, but that this trend would diminish (or possibly even reverse) when a mixed list format is used. The fourth hypothesis was that the

effect of the mixed list versus pure list manipulation on partial recollection would differ compared to the effect of the mixed list versus pure list manipulation on full recollection.

Method

Participants. Participants were 100 undergraduate students from Colorado State University who participated for partial completion of a course requirement. As explained below, the first version of the experiment (Mixed list) had 47 participants. The second version of the experiment (Pure list) had 53 participants.

Materials. Materials were 112 general knowledge questions and one-word target answers taken from the Nelson & Narens (1980) norms. Half of the target word answers were grouped into a HF list, and half were grouped into a LF list. All item characteristics were taken from the English Lexicon Project (Balota et al., 2007), and they can be found in Table 7.

Table 7. Lexical Characteristics of High and Low Frequency Target Words from Experiment 2.

	High Frequency List		Low Frequency List	
	Mean	*(SD)*	Mean	*(SD)*
Log HAL Frequency	*8.02	0.70	*5.75	0.99
Length (number letters)	6.68	1.60	7.00	1.58
Syllables	2.43	0.73	2.25	0.72
Orthographic_N	1.59	2.59	1.41	2.95
Phonographic_N	3.50	5.99	2.95	5.56

* Denotes a significant difference between high and low frequency of $p < .001$. All other *p*s =ns

Log-transformed HAL frequency varies between these lists as confirmed by an independent-samples t-test: [$t(118)=13.96$, SE=.16, $p<.001$]. These lists are also equated for word length,

number of syllables, orthographic neighborhood, and phonological neighborhood. The order of study-test presentation was counterbalanced, such that the 56 study items chosen for the first participant were used as the 56 nonstudied items for the next participant. Item order selection within-participant was randomized. The full list of question and answer stimuli are presented in Appendix D.

Procedure After signing consent forms detailing the nature of the experiment, participants read instructions similar to those used in Experiment 1 on the computer screen prior to beginning. Participants were simply told that they were to remember the study word targets for a later memory test. During the study phase, each participant was presented with an initial fixation cross for duration of 1 sec. They then viewed a one-word answer presented in 30 point Arial Font in the center of the screen for 2 sec each with an interstimulus interval of 1 sec. List type was manipulated between-subjects by creating two list types (Mixed list, Pure list). In the mixed list version of the experiment, frequency within each study block was interleaved, such that they consisted of 7 HF targets and seven LF targets. In the pure list version of the Experiment, each study list was blocked by frequency, such that block 1 was exclusively HF words, and block 2 was exclusively LF words, etc. All stimuli were presented visually using E-Prime software (PST Inc.) on Dell PCs in our laboratory. After viewing each study list in the mixed list version, participants viewed seven general knowledge questions associated with HF targets, seven questions associated with LF targets, and 14 new questions. In the pure list versions, participants viewed 14 general knowledge questions pertaining to either a HF or a LF block and 14 new questions. Participants were first asked to provide a rating of familiarity based on the likelihood that the answer to the test question was studied. Next, participants attempted to retrieve the correct answer to the test question. Finally, they were prompted to provide any

partial information that came to mind if they could not identify the answer the question (e.g., a similar sounding or rhyming word, the first or last letter, or the number of syllables) in line with the instructions used in Cleary (2006). Each trial automatically advanced after 10 sec. This procedure was repeated across four study-test blocks. Spelling of responses was checked offline and coded by hand to determine category membership (i.e., full target recollection, partial target recollection, failed recollection, or new).

Results and Discussion

Full Target Retrieval

For this experiment, an alpha criterion of $p < .05$ was set, and effect sizes are reported. The probabilities of full target retrieval in each condition are displayed in Table 8 and in Figure 6. A 2 X 2 X 2 Study Status (Studied, Nonstudied) X Frequency (HF, LF) X List-Type (Mixed list, Pure list) mixed repeated-measures ANOVA was conducted to assess whether the retrieval advantage for HF over LF targets differed as a function of Study Status, Frequency, or List-type. This analysis revealed no two-way or three-way interactions. As expected, this analysis revealed a main effect of Study Status [$F(1,98)=294.61$, $MSE=.013$, $p<.001$, $p\eta^2 = .75$] such that the rate of full target retrieval was higher for studied targets than for nonstudied targets. A main effect of Frequency was also found [$F(1,98)=103.80$, $MSE=.005$, $p<.001$, $p\eta^2 = .51$] such that HF studied and non-studied answers were retrieved at a higher rate than LF studied and non-studied answers. The finding that a higher degree of full retrieval was seen for HF studied and nonstudied targets provided support for my first hypothesis in Experiment 2.

Table 8. Mean Proportion of Full Retrieval Based on Study Status, List-Type, and Frequency of Targets for Experiment 2.

		Studied	Nonstudied
(List-Type)	(Freq)	Mean (*SD*)	Mean (*SD*)
Mixed	HF	.61 *(.18)*	.41 *(.20)*
	LF	.54 *(.18)*	.33 *(.15)*
Pure	HF	.60 *(.16)*	.40 *(.17)*
	LF	.51 *(.14)*	.34 *(.15)*

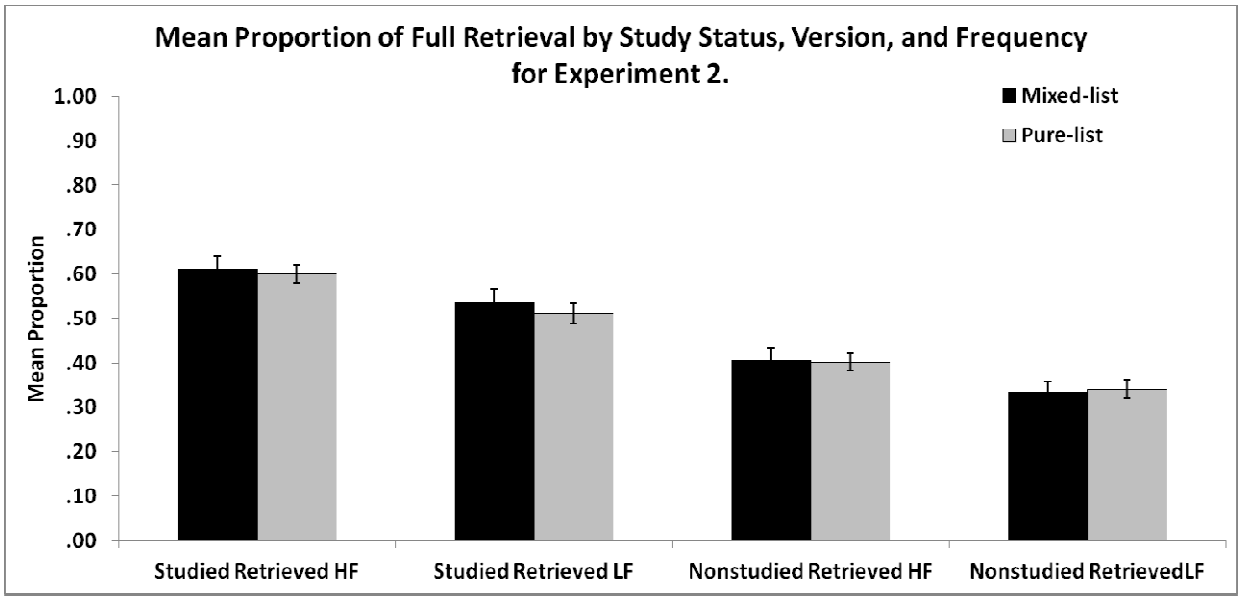

Figure 6 . Mean Proportion of Full Retrieval by Study Status, List-Type, and Frequency for Experiment 2

This finding is in accordance with previous research showing a HF advantage in recall (e.g. Clark & Burchett, 1994; DeLosh & McDaniel, 1996; Duncan, 1974; Gregg, 1976; MacLeod & Kampe; 1996, Mandler, 1980). The lack of an interaction suggests that the HF advantage and the Study Status advantage for full retrieval did not differ based on List-Type (all *F*s <1). This

suggests that the mixed-list paradox did not affect full target retrieval in a general-knowledge paradigm.

Partial Target Recollection when Full Target Retrieval Failed

For the next analyses, partial recollection was operationally defined as any instances of correct identification of a similar sounding word, first letter, last letter, or the number of syllables associated with a target in the absence of being able to fully identify the target itself.[3] The following data can be found in Table 9 and in Figure 7. To assess whether these rates of partial retrieval differed based on study-status, list-type and word frequency, a 2 X 2 X 2 Study Status (Studied vs. Nonstudied) X List-Type (Mixed list vs. Pure list) X Frequency (HF vs. LF) mixed repeated-measures ANOVA was conducted. This test revealed that Study Status did not significantly interact with List-Type ($F<1$) or Frequency ($F<1$), and that List-Type did not interact with Frequency ($F<1$). However a significant main effect of Study Status was found, [$F(1,49)=21.77$, $MSE=.001$, $p<.001$, $p\eta^2=.31$] such that partial retrieval was higher for questions corresponding to nonstudied targets compared to those corresponding to studied targets. This effect was in the opposite direction of that shown for full retrieval. A main effect was also found for List-Type, [$F(1,49)=6.00$, $MSE=.001$, $p=.02$, $p\eta^2=.12$] such that the overall rate of partial retrieval was higher for targets in the Mixed list version of the experiment than in the Pure list version. No main effect was found for Frequency ($F=1$).

[3] As in Experiment 1 (see Footnote 2), incidental partial retrieval also sometimes occurred in Experiment 2 on the identification attempt itself. Although not central to the present study, these data may be of interest, and they are reported in Appendix E.

Questions corresponding to LF targets did not elicit a higher degree of partial retrieval compared to questions corresponding to HF targets. This finding was contrary to the second hypothesis in Experiment 2. In fact, there was no evidence for an effect of frequency on partial recollection at all. The study status advantage shown for full retrieval reverses for partial retrieval, such that nonstudied items elicited significantly more instances of partial retrieval than studied items. This finding is in accordance with the predictions in Cleary (2006) and Cleary and Reyes (2009).

Table 9. Mean Proportion of Partial Retrieval by Study Status, List-type, and Frequency of Targets for Experiment 2.

		Studied	Nonstudied
(List-Type)	(Freq)	Mean (*SD*)	Mean (*SD*)
Mixed	HF	.01 *(.02)*	.03 *(.04)*
	LF	.01 *(.02)*	.03 *(.04)*
Pure	HF	.01 *(.02)*	.02 *(.03)*
	LF	.01 *(.01)*	.02 *(.03)*

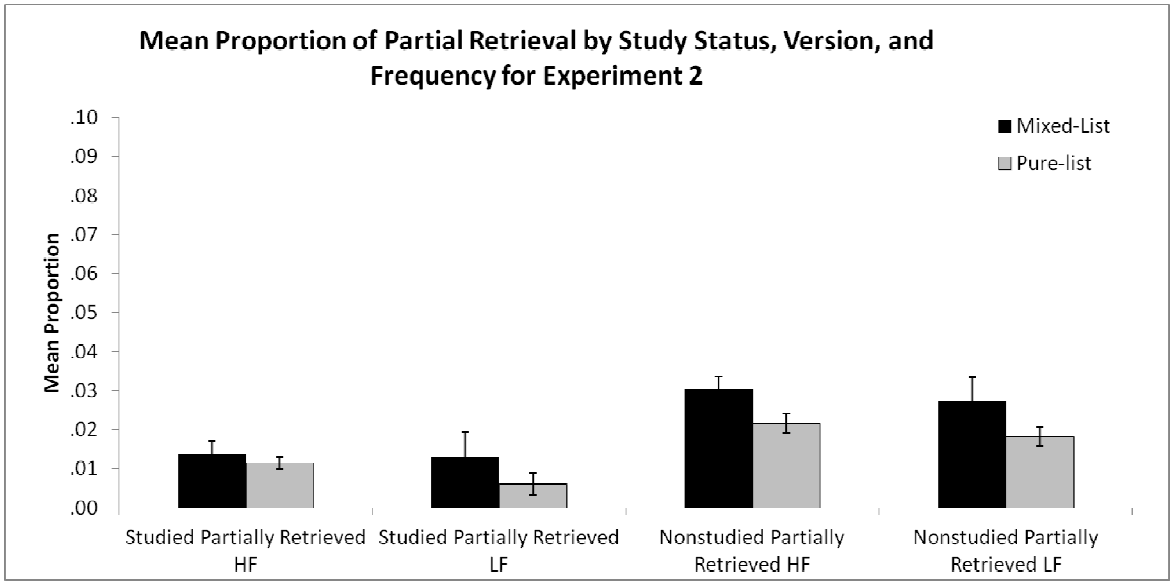

Figure 7. Mean Proportion of Partial Retrieval by Study Status, List-Type, and Frequency for Experiment 2.

This finding is also consistent with the Transmission Deficit (TD) model of TOT states which describes a disruption in the flow of information between the lexical level and phonological level in the brain (Burke, MacKay, Worthley, & Wade, 1991; James & Burke, 2000; Rastle & Burke, 1996; see Schwartz 2002 for a review). Such disruption may be due to below-threshold activation of a representation in semantic memory. In the current study, nonstudied targets would have presumably had lower baseline levels of activation than studied targets. While studied targets more frequently reached a threshold level of activation for full retrieval, nonstudied targets may have remained below this threshold where only access to partial target information was available. This finding is also consistent with theories of partial retrieval in anomic aphasia due to a similar disruption in a relay of information from the level of lexical (semantic) representation to the level of phonological representation necessary for articulation (e.g. Caramazza, 1997; Levelt, Roelofs, & Meyer, 1999; Roelofs, 1997a, 1997b; Harley, 2008; Turken & Dronkers, 2011).

An important observation is that full target retrieval and partial retrieval behaved in a different manner. That is, the rate of full retrieval was highest for studied targets of high frequency, and the effect of list type had little if any impact on this pattern. The rate of partial retrieval was highest for nonstudied targets of both high and low frequency, but list-type did impact this pattern such that nonstudied targets of both frequencies were higher in the mixed-list version than in the pure-list version. It may be that viewing mixed lists of both high and low frequency items served to facilitate higher subthreshold priming of representations than pure lists. This priming would have been below the level necessary for the full retrieval of a target but above the level of priming that would have prevented retrieval of any details.

Recognition Ratings Given in the Presence of Full Target Retrieval

To assess whether recognition ratings given to questions corresponding to fully retrieved targets differed as a function of Study Status, Frequency, or List-type, a 2 X 2 X 2 Study Status (Studied, Nonstudied) X Frequency (HF, LF) X List-Type (Mixed list, Pure list) mixed repeated measures ANOVA was performed on these ratings. These data can be found in Table 10 and in Figure 8. A three-way Study Status X Frequency X List-Type interaction was not found, [$F(1,46)=1.67$, $MSE=1.01$, $p=.20$, $p\eta^2=.24$], nor was a two-way Frequency X List-type interaction ($F=1$) or a two-way Study Status X List-Type interaction ($F(1,46)=1.24$, $MSE=4.01$, $p=.27$, $p\eta^2=.19$]. However, a significant two-way Study Status X Frequency interaction emerged [$F(1,46)=14.43$, $MSE=.60$, $p<.001$, $p\eta^2=.24$], such that ratings given to questions corresponding to studied LF targets were higher than ratings given to questions corresponding to studied HF targets. This pattern reversed for retrieval of nonstudied targets such that ratings given to questions corresponding to nonstudied HF targets were higher than those given to nonstudied LF targets. This pattern may relate to the word frequency mirror effect.

Table 10. Mean Recognition Ratings Given to test Questions Based on Study Status, Retrieval Status, List-Type, and Frequency of Targets for Experiment 2.

		Studied		Nonstudied	
		Retrieved	Not Retrieved	Retrieved	Not Retrieved
(List-Type)	(Freq)	Mean (*SD*)	Mean (*SD*)	Mean (*SD*)	Mean (*SD*)
Mixed-List	HF	8.56 *(1.40)*	4.09 *(1.55)*	3.75 *(2.43)*	3.78 *(1.45)*
	LF	8.86 *(1.76)*	3.80 *(1.49)*	3.18 *(2.32)*	3.50 *(1.29)*
Pure-List	HF	8.86 *(1.02)*	4.29 *(1.40)*	3.29 *(2.11)*	3.36 *(1.16)*
	LF	9.07 *(1.00)*	4.06 *(1.54)*	3.10 *(1.98)*	3.44 *(1.36)*

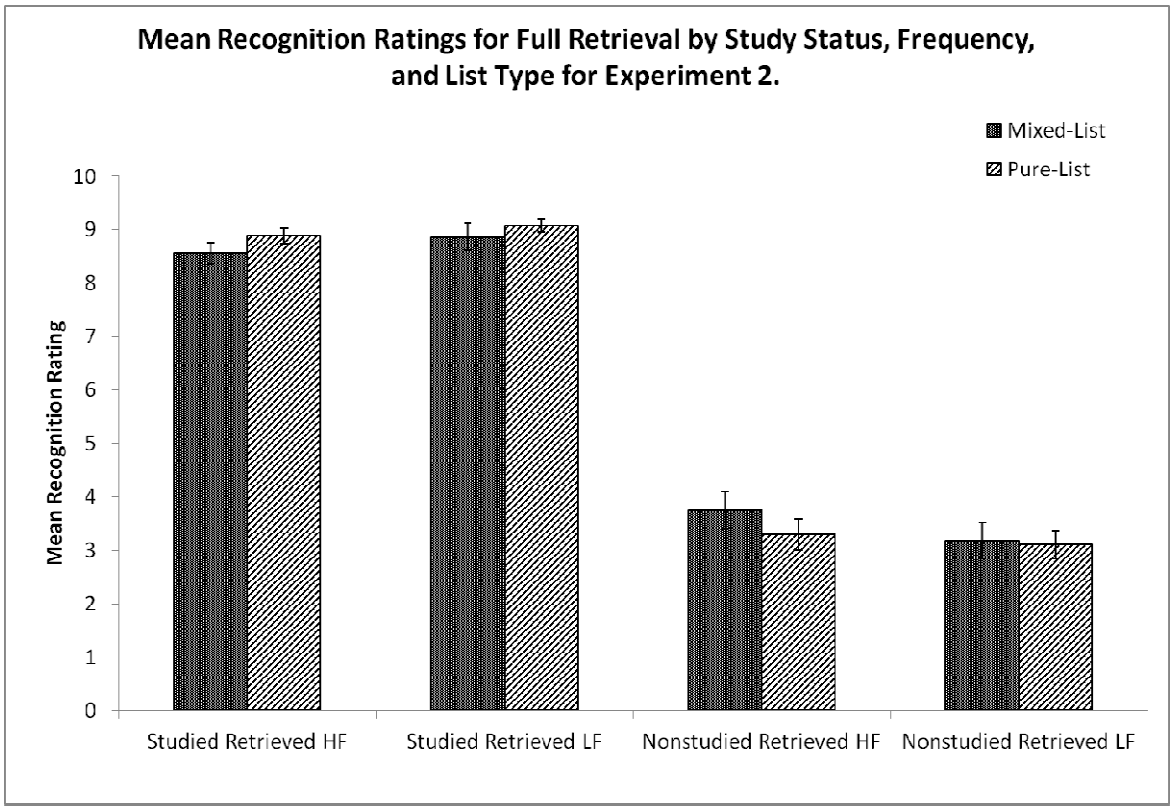

Figure 8.Mean Recognition Ratings for Test Questions Corresponding to Retrieved and Unretrieved Targets by Study Status, List-Type, and Frequency for Experiment 2.

The word frequency mirror effect is the finding that LF items lead to a higher hit rate and a lower false alarm rate in traditional recognition memory tests, whereas HF items lead to a higher rate of false alarms and a lower hit rate (i.e., the pattern for LF is a mirror reversal of that for HF) (Glanzer & Adams, 1985; see Park, Reder, & Dickison, 2005 for a review).
Post-hoc tests adjusted for multiple comparisons revealed that this interaction was driven primarily by a significant difference between nonstudied HF and nonstudied LF targets in the Mixed list condition, [$t(46)=3.07$, $p=.004$, Cohen's $d=.64$]. The difference between Studied LF and Studied HF in the mixed condition did not reach significance, [$t(46)=1.43$, $p=.16$, Cohen's $d=.31$] nor did the difference between Studied LF and Studied HF in the pure-list version [$t(52)=1.53$, $p=.13$, Cohen's $d=.34$] or the difference between Nonstudied LF and Nonstudied

HF in the pure-list version [$t(52)=1.13$, $p=.26$, Cohen's $d=.23$]. A significant main effect of Study Status was found [$F(1,46)=351.42$, $MSE=8.02$, $p<.001$, $p\eta^2=.88$], such that ratings given to questions corresponding to studied targets were higher than ratings given to nonstudied targets. Finally, the ANOVA revealed no main effect of List-type, ($F<1$) or a main effect of Frequency ($F<1$).

Recognition ratings given in the presence of full retrieval, revealed a common LF hit rate advantage such that recognition ratings given to retrieved targets that were studied were higher if the target was LF than if it was HF (e.g., Gardiner & Java, 1990; Shiffrin & Steyvers, 1997). Interestingly, this pattern reversed for retrieval of nonstudied targets, such that HF targets show an advantage versus LF targets. This may relate to dual-process explanations of the word frequency mirror effect, as will be discussed below in the section "Ratings in the Presence of Target Retrieval versus the Absence of Any Retrieval".

Recognition Ratings Given when All Forms of Retrieval Failed

To examine the RWI effect, a 2 X 2 X 2 Study Status (Studied vs. Nonstudied) X Frequency (HF vs. LF) X List-Type (Mixed list vs. Pure list) mixed repeated measures ANOVA was conducted on ratings conditionalized on lack of any kind of retrieval. A magnified version of these effects can be seen in Figure 9. A significant three-way Study Status X Frequency X List-Type interaction was not found ($F<1$). However a significant two-way Study Status X List-Type Status interaction was found, [$F(1,46)=3.70$, $MSE=.96$, $p=.05$, $p\eta^2=.07$] such that in the absence of any retrieval, participants could reliably discriminate between questions whose target answers had been studied and questions whose targets had not been studied, but this RWI effect was *only* found in the pure list version for HF targets [$t(52)=5.67$, $p<.001$, Cohen's $d=1.12$] and LF targets [$t(52)=3.62$, $p=.001$, Cohen's $d=.70$].

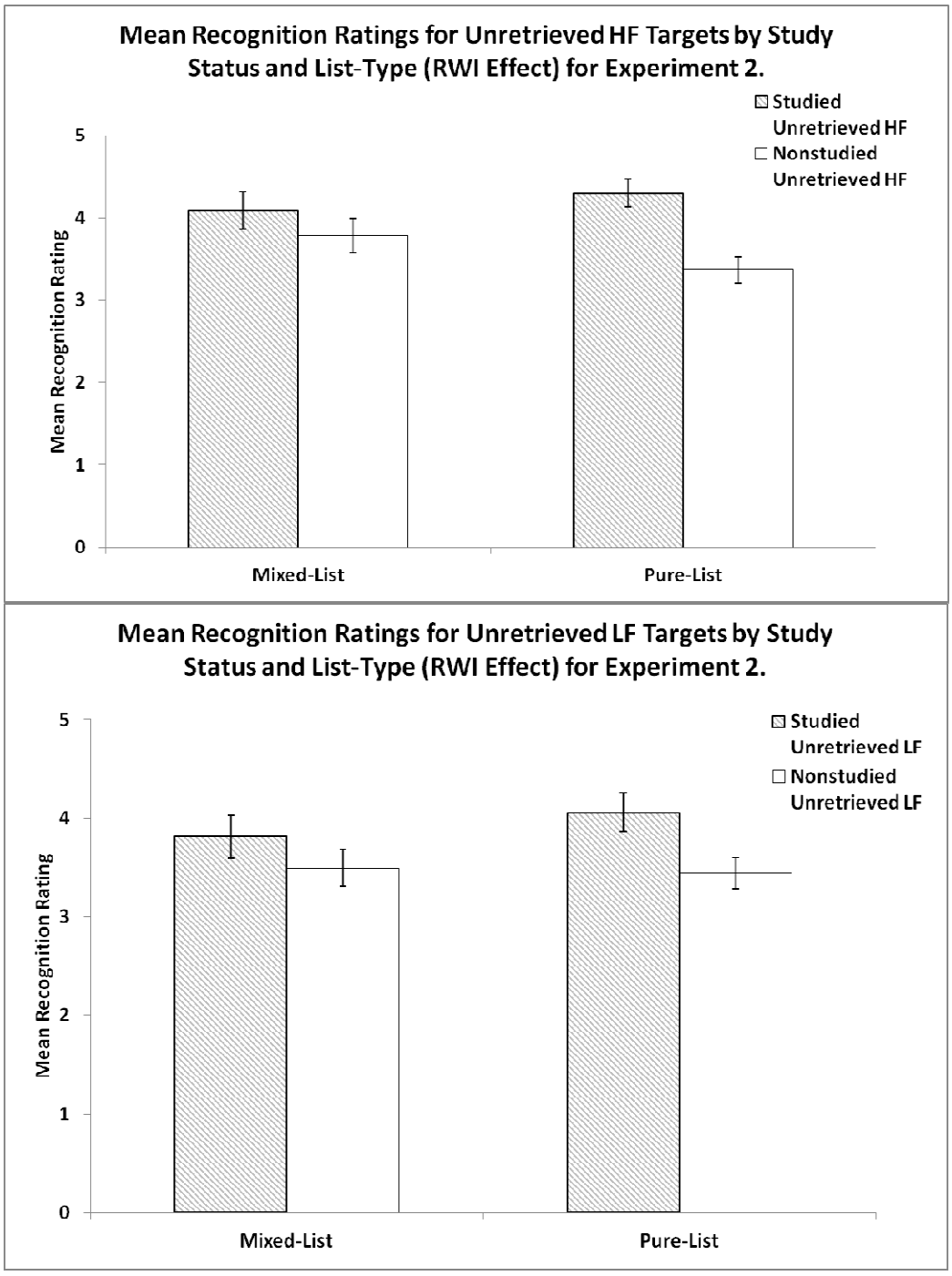

Figure 9. The Recognition without Identification Effect by List-Type for High Frequency Targets (top) and Low Frequency Targets (bottom)

For the mixed list version of the experiment, no RWI effect was found for HF targets [$t(46)=1.20$, $p=.12$, Cohen's $d=.32$] or LF targets [$t(46)=1.59$, $p=.23$, Cohen's $d=.22$]. No other interactions reached significance ($Fs<1$). An expected main effect of Study Status was also

found, [$F(1,46)=35.64$, $MSE=.68$, $p<.001$, $p\eta^2=.48$], such that ratings in the absence of any retrieval were significantly higher when a question corresponded to a studied target than when it corresponded to a nonstudied target. A significant main effect of frequency was also found [$F(1,46)=4.83$, $MSE=.84$, $p=.03$, $p\eta^2=.10$] such that, in the absence of retrieval, ratings given to questions corresponding to HF targets were higher than those given to questions corresponding to LF targets. Finally, no main effect of List-Type was found ($F<1$).

Importantly, in Experiment 2, when complete target retrieval failure occurred, individuals were still able to rate questions corresponding to studied targets higher than those corresponding to nonstudied targets. This is the RWI effect. The magnitude of this effect changed based on list-type, such that it was significant for the pure-list version of the experiment but it disappeared for the mixed list version. This suggests that old/new discrimination in the absence of any retrieval can be influenced by study list-type. The particular influence of list-type shown here is the opposite of a typical list-strength effect.

In recognition memory, a traditional list strength effect is the finding of a decrease in the likelihood of a hit for particular items in a list when the strength of other items in the list is increased, or an increase in the likelihood of a hit of particular items in a list when the strength of other items is reduced (Shiffrin, Ratcliff, & Clark, 1990; Cleary, 2005). In a study examining z-ROCs using the RWI paradigm, Cleary (2005) found a list-strength effect for familiarity such that old/new discrimination of unidentified items was worse in a pure list for weak items than in a mixed list for weak items. Although the manipulation in the present study (frequency) is different from that used by Cleary (exposure duration), the finding that old/new discrimination in the absence of retrieval is diminished in the mixed-list version of Experiment 2 in the present study is the reverse of what she found.

It is also opposite the predictions made by global-matching models of familiarity (e.g., Clark & Gronlund, 1996; Hintzman, 1988; see Ryals & Cleary, 2012). It is not immediately apparent why the opposite of the list-strength effect was found in Experiment 2. One possible explanation is that incidental access to partial information in the mixed list version for nonstudied unretrieved items reduced the RWI effect. As can be seen in Appendix E, the proportion of incidental partial recollections was higher for nonstudied items in the mixed list than it was in the pure list. It is possible that this increase in incidental partial retrieval served to increase the ratings given to nonstudied items for which full retrieval failed. This would reduce the index of old/new discrimination that serves as the basis for the RWI effect. Another interesting possibility is that mixed-frequency lists may lead to greater variance (i.e., a wider distribution) in familiarity for studied items. This greater variance may therefore reduce old/new discriminability overall compared to that for pure frequency lists. That is, pure lists may lead to increased old/new discriminability because familiarity levels in these lists are roughly equivalent.

My third hypothesis, that frequency would interact with list-type to diminish the RWI effect was not directly supported. Rather, the RWI effect was diminished by a reverse list strength effect; a finding that is interesting with regard to recognition memory theory. Just as the behavior of full retrieval differed from that of partial retrieval, it is important to note that the behavior of partial retrieval also differed from that of RWI. Whereas partial retrieval was highest for nonstudied targets in the mixed-list version of the experiment, RWI was found only in the pure-list version of the experiment. This pattern alone suggested that partial retrieval may be fundamentally different than recognition that occurs in the absence of any retrieval.

Ratings in the Presence of Target Retrieval versus the Absence of any Retrieval

To compare how frequency and list-type affected recognition ratings given in the presence of full target retrieval vs. the absence of any retrieval, a 2 X 2 X 2 X 2 Study Status (studied, Nonstudied) X Retrieval Status (target retrieved, no retrieval) X Frequency (HF vs. LF) X List-Type (Mixed list vs. Pure list) mixed repeated measures ANOVA was conducted. These data can be found in Table 10 as well. A four-way Study Status X Retrieval Status X Frequency X List-Type interaction did not reach significance ($F<1$). A three-way Retrieval Status X Frequency X List-Type interaction also did not reach significance ($F<1$), nor did a three-way Study Status X Retrieval Status X List-Type interaction ($F<1$). However, a three-way Study Status X Retrieval Status X Frequency interaction did emerge, [$F(1,98)=8.74$, $MSE=.86$, $p=.004$, $p\eta^2=.08$] which suggests that, when full retrieval succeeded for studied targets, higher ratings were given to questions corresponding to LF targets than to questions corresponding to HF targets. However when all recall failed for studied or unstudied targets, or when a nonstudied target was retrieved, higher ratings were given to questions corresponding to HF targets than to those corresponding to LF targets. A two-way Retrieval Status X List-Type interaction did not reach significance ($F<1$), nor did a two-way Retrieval Status X Frequency Status interaction ($F<1$), or a two-way Frequency X List-Type interaction [$F(1,98)=1.61$, $MSE=.90$, $p=.21$, $p\eta^2=.02$]. A two-way Study Status X List-Type interaction also failed to reach significance [$F(1,98)=2.93$, $MSE=4.19$, $p=.09$, $p\eta^2=.03$]. A significant two-way Study Status X Retrieval Status interaction did emerge, [$F(1,98)=453.99$, $MSE=.07$, $p<.001$, $p\eta^2=.82$] such that ratings given to fully retrieved studied targets were higher than those given to studied targets that were not retrieved, yet the ratings given to nonstudied retrieved targets were lower than ratings given to nonstudied targets for which any retrieval failed. An expected main effect of Study Status was

also found, [$F(1,98)=435.61$, $MSE=4.19$, $p<.001$, $p\eta^2 =.82$] such that overall ratings corresponding to studied targets were higher than overall ratings corresponding to unstudied targets. A main effect of Retrieval Status was also found [$F(1,98)=250.90$, $MSE=4.20$, $p<.001$, $p\eta^2 =.72$] suggesting that overall ratings corresponding to retrieved targets were higher than ratings given to targets for which retrieval failed. Lastly, a marginal main effect of Frequency was found [$F(1,98)=2.92$, $MSE=.90$, $p=.07$, $p\eta^2 =.03$] which suggested that overall ratings corresponding to HF targets were marginally higher than those corresponding to LF targets.

That a LF advantage was shown for studied targets that were fully retrieved but a HF advantage was shown for all other targets (per the three-way interaction above) may be viewed as consistent with the Source-of-Activation-Confusion (SAC) dual-process explanation of the word frequency mirror effect (e.g. Cary & Reder, 2003; Diana, Reder, Arndt, & Park, 2006, Reder et al., 2000). According to this model, a LF word is associated with fewer pre-experimental contexts (i.e., have a smaller fan) than a HF word; and it is, thus, more likely to be recognized as being presented within the experimental context (when studied) upon recollecting because there is less interference coming from occurrences of that same item in prior contexts. Thus, LF words receive higher hit rates than HF words. In contrast, high frequency words are encountered so often in daily life (i.e., have a larger fan) that they are less likely to be recollected as specifically appearing in the experimental context due to the interference of prior contexts. However, HF words, due to their frequency of occurrence, tend to seem more familiar on average than LF words, and thus tend to receive higher false alarms than LF words (Park, Arndt & Reder, 2006).

Applied to the present pattern of results, perhaps LF targets, when retrieved, are more likely to be recognized (via higher recognition ratings) because they have occurred in fewer pre-

experimental contexts than HF targets. When the target was not studied but was retrieved, it seems more familiar when it is a HF than when it is a LF word, due to the frequent pre-experimental exposure. Thus, the familiarity of these retrieved HF non-studied targets results in higher recognition ratings than those given to retrieved non-studied LF targets. When retrieval fails, perhaps high frequency targets, due to their frequent prior pre-experimental occurrence, are still more inherently familiar as well as their corresponding questions, which may contain semantic feature-overlap with those targets (e.g., Ryals & Cleary, 2012). Thus, in the absence of target retrieval, the greater familiarity of the questions corresponding to high frequency words leads to higher ratings for questions corresponding to HF targets, regardless of study status.

Recognition Ratings for Partial Retrieval

While it might be of interest to examine ratings in the presence of only partial retrieval, as in Experiment 1, the low number of instances of partial retrieval in Experiment 2 made it difficult to meaningfully interpret these data. Many subjects did not have even one instance of partial recollection for the mixed-list version (Studied HF= 33, Nonstudied HF=27, Studied LF=34, Nonstudied LF=28 had no instances), and slightly more had no such instances of partial target recollection in the pure-list version (Studied HF= 39, Nonstudied HF=33, Studied LF=43, Nonstudied LF=34 had no instances). Beyond the extreme loss of subjects in trying to compare ratings in this category, there is also the concern that very few such instances occurred even among those subjects who had at least one instance of partial recollection in each category, thus leading to a low number of items contributing to each mean. For these reasons, these data have been placed in Appendix F for the reader's reference.

The manipulation of word frequency in Experiment 2 produced a pattern indicative of a functional dissociation between full recollection, partial recollection, and familiarity that occurs

in the absence of any recollection. A central goal of Experiment 2 was to manipulate a stimulus characteristic that was more inherent to the stimuli themselves than the manipulation used in Experiment 1. Word frequency is primarily a lexical characteristic, such that it refers to the direct meaning of a given word within a language. It is believed that access to lexical characteristics of a target word represents one step of processing along with access to phonological, phonetic, and articulatory characteristics in the multi-stage theory of word production (e.g., Levelt, 1994, 1996). However, inherent characteristics of target words can take other forms. One such characteristic is emotionality. While word frequency capitalizes on the commonality of a target word, these targets can also vary in the degree to which they are inherently positive or negative or whether they are exciting or calming. It could be argued that emotionality is more of a true conceptual (semantic) characteristic than is word frequency. If so, then manipulating emotionality may offer additional insight into the nature of partial recollection. This was the primary goal of Experiment 3 that follows.

Chapter XIII

Experiment 3

Previous research has shown that emotionality is a manipulation that has different effects on recollection and familiarity (e.g., Ochsner, 2000; Kensinger & Corkin, 2003, Ryals & Cleary, 2012). Ryals & Cleary (2012) demonstrated that whereas negative valence and high arousal affected cued recall itself and recognition *with* cued recall, these emotional characteristics did not affect recognition *without* cued recall Other research has indicated that when full target recollection fails, emotional items elicit higher levels of TOT states than nonemotional items (Schwartz, 2010). If this assumption holds, then emotional items should also elicit higher levels of partial recollection than nonemotional items. The ability to recollect partial details should be enhanced for negatively-valenced events that are also arousing in nature (Kensinger, 2009; Mickley-Steinmetz et al., 2010). The purpose of Experiment 3 is to demonstrate that word emotionality (i.e., negative valence coupled with high arousal) should increase the likelihood of partial recollection as well as full recollection. The first hypothesis in Experiment 3 was that the rate of full retrieval would be higher for emotional targets than for neutral targets. The second hypothesis was that the rate of partial retrieval would also be higher for emotional targets compared to neutral targets. The third prediction was that, in the absence of being able to retrieve a target word, participants would be able to discriminate between test questions whose target answers had been studied from those whose answers had not been studied (The RWI effect). Next, it was predicted that a bias would emerge for emotional items in the absence of any retrieval due to the fact that the cues are themselves emotional in nature. This bias was predicted to manifest as an overall increase in recognition ratings for emotional versus neutral targets; however, it was not expected that the magnitude of the RWI effect (old/new discrimination)

would differ as a function of emotion. Finally, I predicted that a bias for emotion in retrieval may occur, such that ratings in the presence of full or partial recollection may differ as a function of emotionality condition.

Method

Participants. Participants were 118 undergraduate students from Colorado State University who participated for partial completion of a course requirement. Eight participants were excluded from analyses due to noncompliance of instructions resulting in a final sample of 110.

Materials. Materials were 112 general knowledge questions and one-word target answers created in our laboratory similar to those used by Schwartz (2010).[4] Given that Schwartz did not control for dimensions of valence, arousal, word frequency, orthography, phonology, word length, or number of syllables using preexisting norms, new stimuli controlling for these dimensions were created for this Experiment. Emotional and neutral target words were normed using the ANEW affective word database (Bradley & Lang, 1999). Emotional and lexical characteristics of these stimuli are presented in Table 11.

[4.] A separate norming experiment was conducted to determine the correct identification rate of the general knowledge questions used in Experiment 3. Fifty-two participants viewed all 112 general questions created in our laboratory in four separate blocks. Order of item presentation was randomized within each block. Participants were asked to answer the question when it appeared on the screen, and then they were asked to rate the difficulty of the question on a scale of 1-10 (1= extremely easy, 10= extremely difficult). Participants answered an average of 41% of the questions correctly (M=.41, SD=.07). Participants also rated the difficulty of the questions that were correctly identified at a level of 2.23/10 (SD=1.34), and they rated the difficulty of those that they did not identify at a level of 4.40/10 (SD=2.44). At least one correct response was recorded for each of the 112 questions.

Valence ratings significantly differed between emotional and neutral items: [$t(110)=30.76$, SE=.11, $p<.001$], as did arousal ratings [$t(110)=11.82$, SE=.11, $p<.001$]. These lists were also equated for word length, word frequency, number of syllables, orthographic neighborhood, and phonological neighborhood. General knowledge questions were created by using dictionary definitions for each target word (Merriam-Webster's Collegiate Dictionary, 2005). The order of study-test presentation was counterbalanced across two experimental versions, such that the 56 study words chosen for the first participant were used as the 56 nonstudied items for the next participant. Item order selection within-participant was randomized. The full list of question and answer stimuli are presented in Appendix G.

Table 11. Lexical Characteristics of Emotional and Neutral Words from Experiment 3.

	Emotional List		Neutral List	
	Mean	*(SD)*	Mean	*(SD)*
Mean Arousal Rating	*6.60	0.52	*5.30	0.63
Mean Valence Rating	*1.99	0.23	*5.47	0.81
Log HAL Frequency	8.13	1.55	8.63	1.31
Length (number letters)	6.60	1.62	6.30	1.61
Syllables	2.09	0.69	2.04	0.76
Orthographic_N	2.16	3.99	2.10	3.26
Phonographic_N	5.14	5.99	5.66	10.48

* Denotes a significant difference between emotional and neutral lists of $p<.001$. All other *p*s =ns

Procedure. After signing consent forms detailing the nature of the experiment, participants read instructions similar to those used in Experiment 1 and 2 on the computer screen prior to beginning. Participants were simply told that they are to remember the study word targets for a later memory test. During the study phase, each participant was presented with an initial fixation cross for 1 sec. They then viewed a one-word answer presented in 30 point Arial Font in the center of the screen for 2 sec each with an interstimulus interval of 1 sec. Each study block consisted of seven emotional targets and seven neutral targets randomly ordered. All stimuli were presented visually using E-Prime software (Psychology Software Tools, Pittsburgh, PA) on Dell PCs in our laboratory. After viewing each study list, participants viewed seven question associated with emotional targets, seven questions associated with neutral targets, and 14 new questions. Participants were then asked to provide a rating of familiarity, an attempt at identification, and then to provide any partial information that came to mind if they were unable to identify the answer (e.g., a similar sounding word, first or last letter, number of syllables). Each trial automatically advanced after 10 sec. This procedure was repeated across four study-test blocks. Spelling of responses was checked offline and items were coded by hand to determine category membership (i.e., full target recollection, partial target recollection, failed recollection, or new).

Results and Discussion

Full Target Retrieval

For this experiment, an alpha criterion of $p < .05$ was set, and effect sizes are reported. A 2 X 2 Study Status (Studied, Nonstudied) X Emotion Condition (Emotional, Neutral) Repeated Measures ANOVA was conducted to assess rates of full retrieval per Study Status and Emotion category. The following results are presented in Table 12 and Figure 10. This analysis revealed a

two-way Study Status X Emotion Interaction [$F(1,109)=4.72$, $MSE=.008$, $p<.03$, $p\eta^2=.04$], such that the difference between the retrievability of neutral and emotional answers was greater when the answers were studied than when they were not studied. Pairwise t-tests confirmed that the rate of full retrieval was significantly higher for studied neutral targets than for studied emotional targets [$t(109)=4.62$, $p<.001$, Cohen's $d=.68$], yet the rate of full retrieval was only marginally higher for nonstudied neutral targets compared to nonstudied emotional targets [$t(109)=1.90$, $p=.06$, Cohen's $d=.25$]. This analysis also revealed a main effect of Study Status, [$F(1,109)=416.46$, $MSE=.009$, $p<.001$, $p\eta^2=.80$], such that questions whose answers were studied were more likely to be answered than questions whose answers were not studied. Finally, a main effect of Emotion Condition was also found, [$F(1,109)=25.25$, $MSE=.006$, $p<.001$, $p\eta^2=.20$], such that neutral answers were more likely to be retrieved than emotional answers.

Table 12. Mean Proportion of Full Retrieval Based on Study Status, and Emotion for Experiment 3.

	Studied	Nonstudied
(Emotion)	Mean (*SD)*	Mean (*SD)*
Neutral	.60 *(.13)*	.39 *(.11)*
Emotional	.55 *(.11)*	.38 *(.10)*

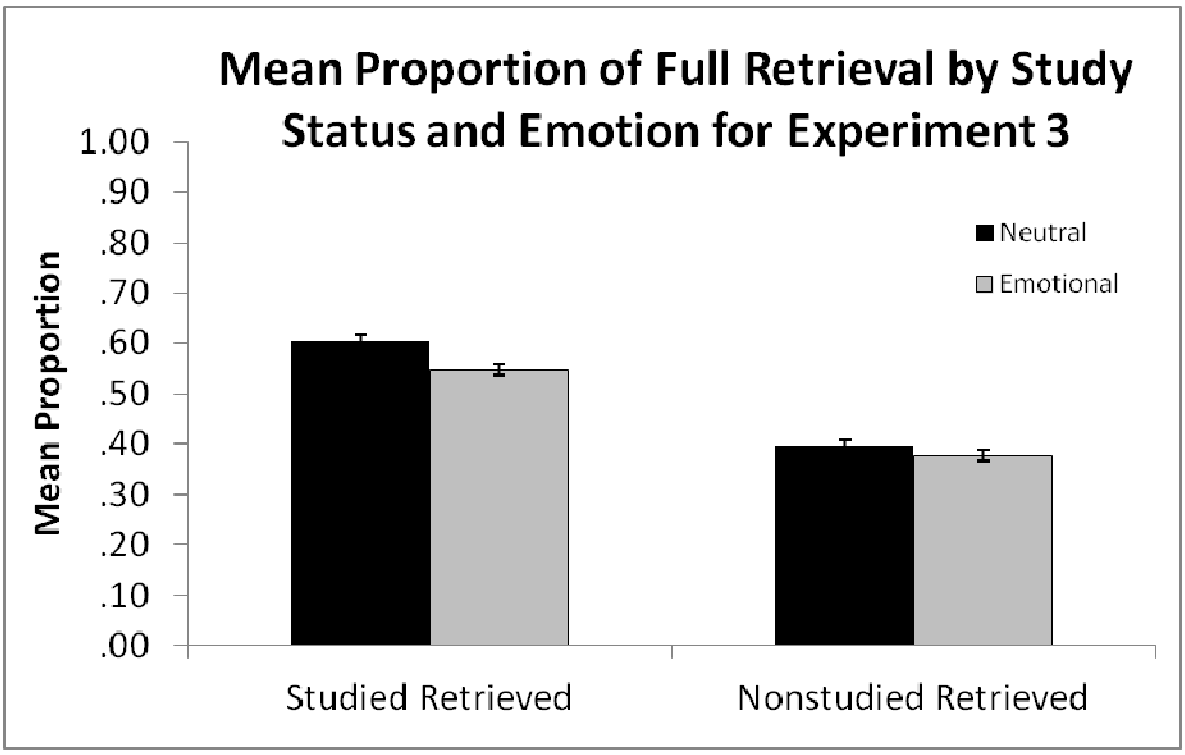

Figure 10. Mean Proportion of Full Retrieval by Study Status and Emotion for Experiment 3.

The finding that full target retrieval was higher for questions corresponding to neutral studied targets compared to those corresponding to studied emotional targets was the opposite of my first hypothesis in Experiment 3. There are at least two possible explanations for this pattern. The first is that the general knowledge questions in the emotional condition were simply harder-to-answer questions than those in the neutral condition. Indeed, examination of the norming data for the stimuli used in Experiment 3 confirmed that, among questions that were successfully answered, emotional questions were rated higher (M=2.72, SD=1.20) than neutral questions (M=2.30, SD=.94) on a difficulty scale [$t(55)$=1.93, p=.06, Cohen's d=.46], but this effect only approached significance. However, the norming data suggest that the rate of correct answers given to emotion questions (40%) was actually slightly higher than the rate of correct answers given to neutral questions (37%), although this difference was not statistically significant; this

suggests that the general knowledge questions in the emotional condition were not harder to answer than those in the neutral condition.

The second explanation is that, rather than leading to an enhancement in recollection, negative valence combined with high arousal may serve to harm recollection. This finding may reflect the use of a within-subjects design whereby participants were exposed to both emotional and neutral items in the same lists. It is possible that the combination of low valence and high arousal in this circumstance served to blur the ability to discriminate between items within the same list.

This finding is not without precedent in the recognition memory literature. For instance, Kensinger, Piguet, Krendl, and Corkin (2005) proposed that trade-offs are possible in emotional memory whereby retrieval of some details of an event is enhanced while memory for other details is diminished. One form of this is known as the gist/detail trade-off (e.g., Buchanan, Tranel, & Adolphs, 2005). In the gist/detail trade-off, negative arousal is believed to lead to an enhanced memory for gist (i.e., the general essence of an experience) but diminished memory for specific details of an experience. This is in contrast to a central/peripheral trade-off whereby central details of an emotional experience are enhanced while memory for surrounding peripheral details is diminished (e.g., Loftus, 1979). Kensinger,Garoff-Eaton, & Shacter (2008) proposed that both types of trade-offs are possible in emotional memory. In particular, Kensinger et al. propose that the gist/detail trade-off may be more likely to occur "when participants are asked to focus on the verbal descriptions of scenes or to follow a storyline regarding an emotional event" (page 576). In Experiment 3, the general knowledge questions were created using verbal descriptions of negative arousing words based on dictionary definitions. This is

notably different than the type of stimuli that typically elicit a central/peripheral tradeoff (i.e., visual scenes with a central emotional element).

Partial Target Retrieval When Full Target Retrieval Failed

Partial retrieval was operationally defined as any instance of correct identification of a similar sounding word, first letter, last letter, or the number of syllables associated with a target in the absence of being able to fully identify the target itself.[5] A 2 X 2 Study Status (Studied, Nonstudied) by Emotion Condition (Emotional, Neutral) repeated measures analysis of variance (ANOVA) was conducted to examine rates of partial retrieval when full retrieval failed based on study status and emotion. These results are displayed in Table 13 and in Figure 11. A two-way Study Status X Emotion interaction did not reach significance [$F(1,109)=2.54$, $MSE=.001$, $p=.11$, $p\eta^2=.10$]. Additionally, a main effect of Study Status did not reach significance ($F<1$). This analysis did however reveal a main effect of Emotion Condition [$F(1,109)=12.34$, $MSE=.001$, $p=.001$, $p\eta^2=.10$] such that a higher rate of partial target recollection occurred for unretrieved emotional targets than for unretrieved neutral targets. Pairwise comparisons confirmed that questions corresponding to studied emotional targets elicited a marginally higher degree of partial recollection than those corresponding to studied neutral targets [$t(109)=1.77$, $p=.08$, Cohen's $d=.24$]. Additionally, questions corresponding to nonstudied emotional targets elicited a significantly higher level of partial retrieval than those corresponding to nonstudied neutral targets, [$t(109)=3.61$, $p<.001$, Cohen's $d=.61$].

[5] Incidental partial retrieval (see Footnotes 2 and 4) also occurred in Experiment 3. Although not central to the present study, these data may be of interest, and they are reported in Appendix H.

Table 13. Mean Proportion of Partial Retrieval by Study Status and Emotion for Experiment 3.

	Studied	Nonstudied
(Emotion)	Mean (*SD*)	Mean (*SD*)
Neutral	.03 *(.04)*	.02 *(.04)*
Emotional	.04 *(.04)*	.04 *(.05)*

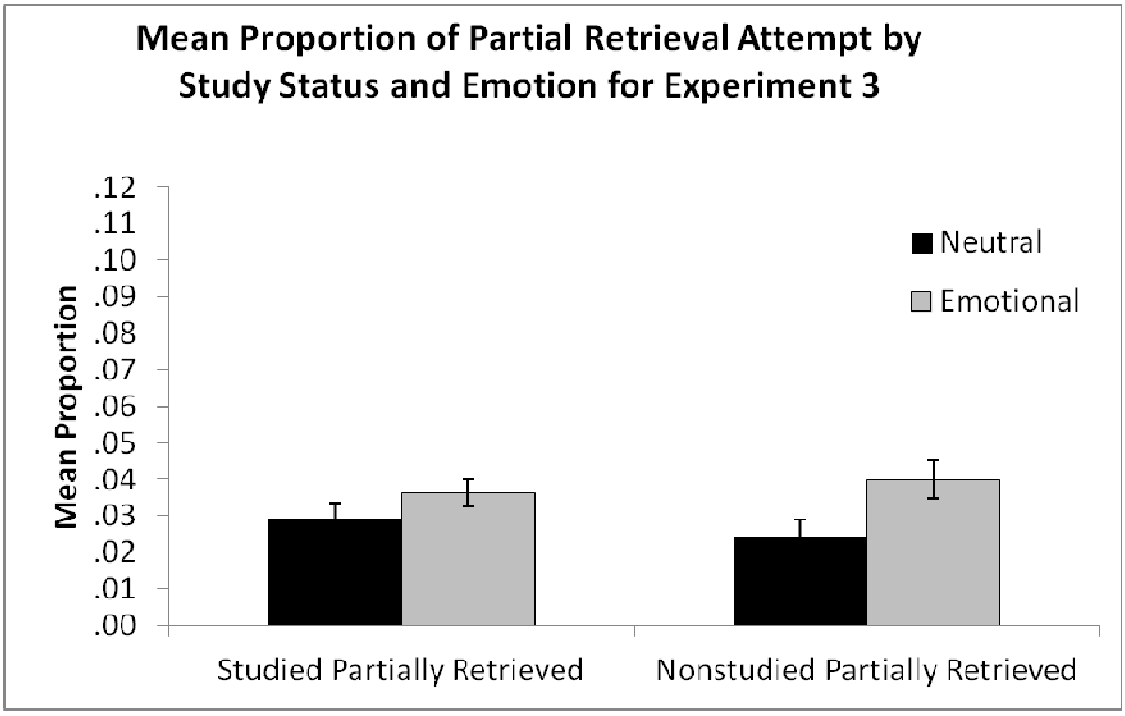

Figure 11. Mean Proportion of Partial Retrieval by Study Status and Emotion for Experiment 3.

The finding that the proportion of partial retrieval was higher for emotional items compared to neutral items directly supports the second hypothesis in Experiment 3. This was reflected in both purposeful and incidental partial retrieval. This finding suggests that negative arousal may have a differential effect on full retrieval than it does on partial retrieval.

Recognition Ratings Given in the Presence of Full Target Retrieval

To examine recognition ratings given in the presence of full target retrieval, data were conditionalized on recalled status. These data are presented in Table 14 and Figure 12. A 2 X 2 Study Status (Studied, Nonstudied) X Emotion Condition (Emotional, Neutral) repeated measures analysis of variance (ANOVA) did not reveal a two-way Study Status X Emotion Interaction ($F<1$). However, an expected main effect of Study Status was found, [$F(1,109)=350.75$, $MSE=6.42$, $p<.001$, $p\eta^2 =.76$]. Ratings were significantly higher for fully retrieved studied answers than for fully retrieved non-studied answers. A marginal main effect of Emotion Condition was also found [$F(1,109)=3.64$, $MSE=.51$, $p=.06$, $p\eta^2 =.03$], which suggests that recognition ratings for questions corresponding to fully retrieved emotional targets were marginally higher than those corresponding to fully retrieved neutral targets.

There was some evidence for a bias due to emotion corresponding to fully retrieved targets. This is consistent with the findings of Ryals & Cleary (2012) who demonstrated a similar bias for high arousal associated with recalled targets in an RWCR paradigm. Ryals and Cleary proposed that individuals may be biased to rate emotional items higher than nonemotional items once they are generated at test. A bias also appeared for nonstudied emotional targets that were fully retrieved. This is also consistent with Ryals & Cleary (2012) who proposed that, when a nonstudied target is retrieved, individuals attribute the emotionality of that generated target to having studied it in the context of the experiment.

Table 14. Mean Recognition Ratings by Study Status, Retrieval Status, and Emotion for Experiment 3.

	Studied		Nonstudied	
	Retrieved	Not Retrieved	Retrieved	Not Retrieved
(Emotion)	Mean (*SD*)	Mean (*SD*)	Mean (*SD*)	Mean (*SD*)
Neutral	7.89 *(1.82)*	3.22 *(1.65)*	3.34 *(1.60)*	3.15 *(1.44)*
Emotional	8.00 *(1.68)*	3.66 *(1.52)*	3.50 *(1.59)*	3.14 *(1.44)*

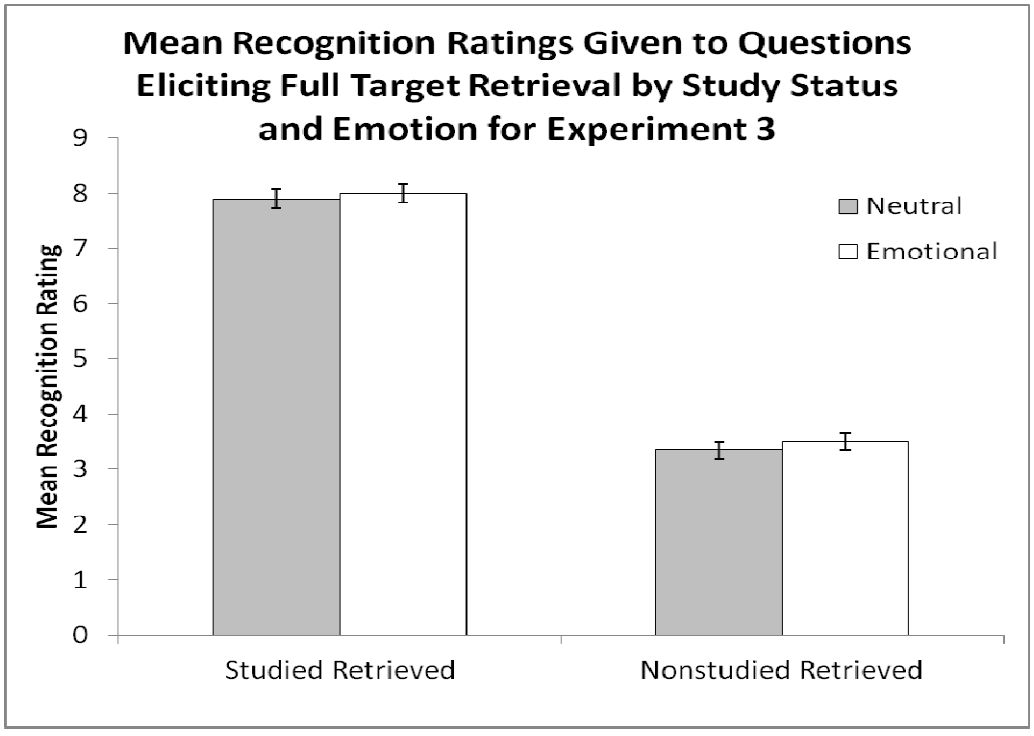

Figure 12. Mean Recognition Ratings Given to Questions Eliciting Full Target Retrieval by Study Status and Emotion for Experiment 3.

.

Recognition Ratings Given When All Forms of Retrieval Failed

To examine ratings given in the absence of any retrieval, data were conditionalized on lack of ability to identify any information about the target. These data can also be found in Table 14 and in Figure 13. A 2 X 2 Study Status (Studied, Nonstudied) X Emotion (Emotional, Neutral) repeated measures analysis of variance (ANOVA) did not reveal a two-way Study Status X Emotion Condition interaction [$F(1,109)=2.52$, $MSE=.52$, $p=.12$, $p\eta^2=.02$]. However this analysis did reveal a main effect of Study Status [$F(1,109)=$ $MSE=.62$, $p=.02$, $p\eta^2=.05$] such that, in the absence of any retrieval, ratings were higher for questions whose targets were studied than for those whose targets were not studied.

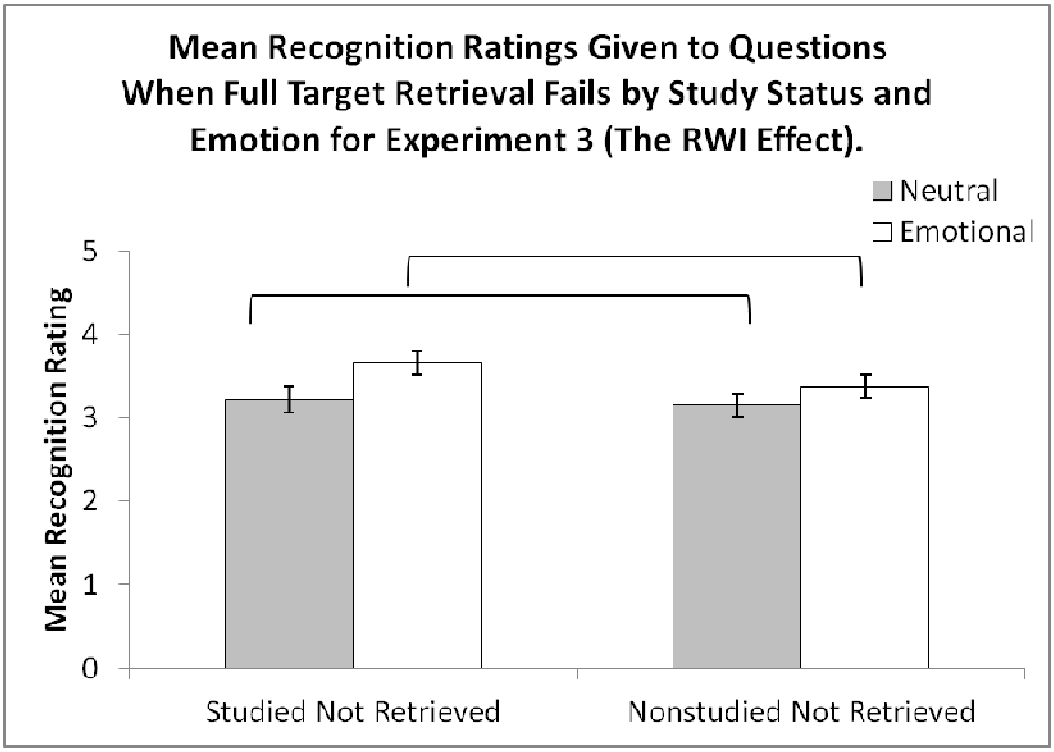

Figure 13. Mean Recognition Ratings for Questions When Target Retrieval Failed by Study Status and Emotion for Experiment 3 (The RWI Effect).

This pattern indicates the presence of the RWI effect and the lack of a significant interaction suggests that its magnitude did not differ significantly as a function of Emotion Condition. However, paired samples t-tests suggest that, when all retrieval failed, participants were still able to discriminate between test questions corresponding to studied emotional targets from those corresponding to nonstudied emotional targets [$t(109)=2.81$, $p=.006$ Cohen's $d=.38$], but were unable to discriminate between test questions that corresponded to studied neutral questions and those corresponding to nonstudied neutral questions when retrieval failed [$t(109)=.70$, $p=.48$, Cohen's $d=.08$]. In short, the RWI effect only appeared in the emotion condition, and the lack of a significant interaction may have been an issue of insufficient power to detect the interaction ($p = .12$). It is possible that with more participants, that interaction would approach significance.

As far as why the RWI effect should only emerge in the emotion condition and not the neutral condition, it is possible that RWI is driven by feature overlap between the cue and items in memory (e.g., Ryals & Cleary, 2012), and that there is a greater degree of such overlap when both the cues (i.e., test questions) and items in memory (i.e., answers) contain emotional information in addition to regular semantic information. For example, the test question "what is another name for a sleep state described by a sense of oppression and hopelessness?" has several overlapping semantically-related emotional components with the target answer "nightmare." Prior research suggests that semantic features lead to smaller RWI effects than other types of features, such as orthographic features (Cleary, 2004). Increasing study-test feature-overlap by adding emotional features to the study and test items may represent a means of enhancing semantic-based RWI effects. Thus, it is possible that with a substantially large increase in experimental power, an RWI effect for neutral targets would emerge as well; it may just be a

small effect, as Cleary (2004) showed to be the case with situations of RWI produced by semantic feature overlap.

A main significant effect of emotion was also found, [$F(1,109)=12.58$, $MSE=.83$, $p<.001$, $p\eta^2 =.12$], such that ratings were higher overall for questions corresponding to unretrieved emotional targets than for questions corresponding to unretrieved neutral targets. One explanation for this pattern might be that the questions themselves, in the case of the emotional condition, actually contain emotional information. For example, the question for the target "kamikaze" contains the word suicide, which is in itself a negatively-valenced word. Thus, the emotional nature of the questions in the emotional condition might have led to the bias to give higher ratings when retrieval failed in this condition than in the neutral condition. Prior work suggests that arousal, in particular, may be attributed to study-status (e.g., Goldinger & Hansen, 2005; Ryals & Cleary, 2012). In addition, prior research has noted that old/new discrimination in the absence of retrieval (familiarity) may involve having a gist-based "feeling" of prior experience when several items in a list share common features (e.g., Reyna & Brainerd, 1995; Schacter, Norman & Koustaal, 1998; Westerburg et al., 2006). If so, this is consistent with a gist/detail trade-off for emotion in memory.

It is interesting to note that although full retrieval was worse for neutral than for emotional targets, recognition ratings for studied items that were not retrieved were higher for emotional items than for neutral items. It is possible that a trade-off occurred such that negative arousal served to hurt memory for details (full retrieval) but enhanced memory for gist (recognition in the absence of full retrieval). This finding is theoretically interesting in light of the prediction that an interaction between valence and arousal may be crucial to understanding how emotion operates in memory (Mickley-Steinmetz et al., 2010).

Ratings in the Presence of target Retrieval versus the Absence of any Retrieval

To compare recognition ratings given in the presence of full retrieval to those given in the absence of full retrieval, a 2 X 2 X 2 Retrieval Status (Full, None) X Study Status (Studied, Nonstudied) X Emotion (Emotional, Neutral) repeated measures ANOVA was conducted. These data can also be found in Table 14. A three-way Retrieval X Study Status X Emotion Interaction did not reach significance ($F=1$), nor did a two-way Study Status X Emotion interaction reach significance ($F<1$). However, significant two-way Retrieval X Study Status interaction was found [$F(1,109)=309.03$, $MSE=3.36$, $p<.001$, $p\eta^2 =.74$], such that the difference between ratings given to studied identified targets and those given to studied unidentified targets was larger than, the difference between identified and unidentified nonstudied targets. A two-way Retrieval X Emotion Status interaction was marginally significant, [$F(1,109)=3.70$, $MSE=.65$, $p=.06$, $p\eta^2 =.06$], such that the difference between neutral and emotional targets was marginally greater for retrieved than for unretrieved targets. A main effect of Study Status was found, [$F(1,109)=330.78$ $MSE=3.68$, $p<.001$, $p\eta^2 =.75$] suggesting that overall ratings were higher for studied than for nonstudied targets. A main effect of Retrieval was also found, [$F(1,109)=282.05$, $MSE=4.23$, $p<.001$, $p\eta^2 =.72$] which suggests that overall ratings were higher for fully retrieved targets than for targets for which all retrieval failed. Finally, a main effect of Emotion was also revealed, [$F(1,21)=17.43$, $MSE=.69$, $p<.001$, $p\eta^2 =.14$] which suggests that overall ratings given to emotional targets were higher than those given to neutral targets.

An important aspect of this analysis is that recognition in the presence of full retrieval behaved in a characteristically different manner from RWI. That is, full target retrieval was higher for both studied and nonstudied emotional targets compared to studied and nonstudied

neutral targets. On the other hand, old/new discrimination in the absence of retrieving any target information (RWI) was present for emotional cues but not for neutral cues.

Recognition Ratings for Partial Recollection

As in Experiments 1 and 2, due to the low number of instances of partial retrieval for target-related information in Experiment 3, it is difficult to interpret the ratings in any meaningful way. Many subjects did not have even one instance of partial recollection for the studied targets (Emotional=58, Neutral=52) and slightly more had no such instances of partial target recollection for nonstudied targets (Emotional=60, Neutral=68). These data have been placed in Appendix I for the reader's reference.

Chapter XIV

General Discussion

The present study contained a series of three experiments aimed at providing behavioral evidence that partial recollection is a distinct entity in recognition memory. This was done by examining perceptual complexity, word frequency, and emotionality within a modified RWI paradigm using general knowledge questions and answers.

Perceptual Complexity

While there was an a priori reason to hypothesize that partial retrieval may increase with increased stimulus complexity (e.g., Parks et al., 2011) the results of Experiment 1 did not support that hypothesis. Although the likelihood of retrieving an answer to a studied target was higher than that of retrieving an answer to an unstudied target, an incremental increase in the degree of perceptual information available at encoding (color and shapes) did not impact full target retrieval. Partial retrieval was separated into two distinct categories; target-related information (i.e., first letter, last letter, syllables, similar-sounding word) and contextual information (i.e., background color, background shape). Level of complexity did not impact the likelihood of partial target retrieval. Surprisingly, nonstudied targets were just as likely to produce partial target recollection as studied targets. Partial contextual retrieval occurred more often than partial target retrieval, though the results suggest that a target must be fully retrieved in order to also retrieve contextual information that was paired with it at encoding. Even for fully retrieved targets, the manipulation of stimulus complexity had no discernible effect on the amount of partial contextual retrieval available. Taken together, these results are inconsistent with the complexity hypothesis proposed by Parks (2007) and Parks et al., (2011).

Recognition ratings also did not reliably differ as a basis of complexity level for studied retrieved targets or studied unretrieved targets. An RWI effect indicated that, when all forms of retrieval failed, participants were able to distinguish between questions that corresponded to studied targets from those that did not based on ratings of familiarity. This replicates previous work by Cleary (2006) using a similar method. Level of stimulus complexity had no effect on the magnitude of the RWI effect.

Although partial recollection did indeed occur for both target-related and contextual information, a striking finding from Experiment 1 was the relative rarity with which either type occurred. Many participants failed to have even one instance of partial retrieval which prevented meaningful examination of recognition ratings for these items. This is quite different than the pattern of full retrieval and full retrieval failure which all participants experienced to a certain degree. This may be one form of evidence that full and partial retrieval are two distinct states in memory.

Word Frequency

The results of Experiment 2 suggested that factors other than perceptual complexity may be important for studying partial retrieval empirically. In Experiment 2, a typical HF advantage was shown for full retrieval (e.g., DeLosh & McDaniel, 1996) and full retrieval was higher for studied than nonstudied targets. This pattern was unaffected by the mixed-list paradox. Prior work has shown that order information is critical to the paradox (e.g., Morin et al., 2006). However, questions and answers in Experiment 2 did not involve order information. More partial target retrievals occurred for nonstudied than studied targets in Experiment 2. This is opposite the pattern shown for full retrieval. Additionally, more partial retrievals occurred in the

mixed list condition than in the pure list condition. This is also different than the pattern shown for full retrieval.

The recognition ratings data for fully retrieved targets were consistent with a word-frequency mirror effect, such that full retrieval of studied targets showed a benefit for LF while full retrieval of nonstudied targets showed a benefit for HF (e.g., Park, Reder, & Dickison, 2005). Ratings given in the absence of any sort of retrieval once again revealed an RWI effect, such that participants could discriminate between questions corresponding to studied targets from those corresponding to nonstudied targets, presumably based on familiarity. However a reverse list-strength effect diminished RWI in the mixed list version of the experiment (i.e., RWI was only found in the pure-list version) (e.g., Cleary, 2005). Once again, the rarity of partial target retrieval in Experiment 2 prohibited any meaningful interpretation of recognition ratings given to partially retrieved targets. However, the finding that more partial retrieval occurred in the mixed-list version of the experiment than the pure-list version is different than the pattern shown by the RWI effect (i.e., it was present in the pure-list version but absent in the mixed-list version).

Emotionality

The results of Experiment 3, which examined stimulus emotionality, also suggest that partial retrieval may be a distinct entity. The rate of full target retrieval was higher for questions corresponding to studied neutral targets than for questions corresponding to studied emotional (i.e., negatively arousing) targets. The opposite pattern was observed for the rate of partial retrieval, which was higher for questions corresponding to emotional targets than for those corresponding to neutral targets.

When all retrieval failed, recognition ratings were higher for questions corresponding to studied targets than those corresponding to neutral targets, but this RWI effect was only found in the emotional condition of the experiment (i.e., it disappeared in the neutral condition). This is consistent with a gist/detail tradeoff in memory whereby negative valence may serve to harm retrieval but enhance gist familiarity (e.g., Westerburg et al., 2006; Kensinger et al., 2008). It is also consistent with the notion that feature-overlap between studied items and the test cue may drive the familiarity presumed to be responsible for the RWI effect (Ryals & Cleary, 2012). Semantic features tend to lead to smaller RWI effects than more perceptual features (Cleary, 2004), and increasing the degree of feature overlap between a studied target and the test question by including emotional features in both may increase the magnitude of the RWI effect, which would explain why the effect was only found in the emotional condition of Experiment 3.

Finally, that participants were biased to give higher recognition ratings to emotional studied and nonstudied targets that were fully retrieved is in accordance with previous work (e.g., Ryals & Cleary, 2012). Overall, the results of Experiment 3 suggest that emotionality in recognition memory can influence not only the subjective confidence associated with emotional past episodes, but that it can influence full as well as partial veridical memory as well (Kensinger, 2009). Furthermore, the results of Experiment 3 may serve to inform theory regarding the interaction of negative valence and high arousal in memory (Mickley-Steinmetz et al., 2010).

Partial Retrieval: Purposeful or Incidental?

An interesting and unanticipated finding in the present study was partial retrieval occurring *on* the identification attempt itself in addition to occurring when participants were prompted *after* the identification attempt. Although it was not central to the purpose of the

present study, this type of incidental partial retrieval occurred quite frequently in Experiments 2 and 3.That is, when a participant provided the wrong answer to a question, their wrong answer sometimes contained partial information from the correct target. For instance, if a participant responded with the answer "*trombone"* to the question "*what is the name of the brass instrument with a blaring tone and only three keys?"*, then this was counted as a partial recollection due to the answer having the same first two letters "*tr*" and the same third letter "*m"*. This type of partial retrieval may be fundamentally different than being able to indicate that a target had "two syllables" when prompted to provide such information. It is quite possible that the first type of partial retrieval occurs outside of awareness (i.e., the participant accessed the word *trombone* without knowing it as reflected in partial information indicated *on* the identification attempt).

There is precedence for this possibility in the memory literature. One example is in studies of implicit memory using the word-stem completion task (WSC) (e.g., Badgaiyan and Posner, 1997; Graf & Schacter, 1985; Schacter et al., 1996; Squire et al., 1992). In this task, participants first study a list of words and are later asked to complete a word stem using the first word that comes to mind without being told that their memory is being tested. Even though the participants complete the word-stems with studied words, they are unaware that they are doing so (See Badgaiyan, 2005 for a review). This suggests that access to partial semantic information can occur below the threshold of conscious awareness.

A similar finding is shown in anterograde amnesics that demonstrate learning of verbal material over time despite having no explicit retrieval of having learned the material before (e.g., Warrington & Weiskrantz, 1970, 1974). In the recognition memory literature, it has recently been proposed that memory tasks presumed to tap only explicit memory may actually capture implicit memory as well (Voss, Lucas, & Paller, 2012). The tasks used in the present study may

be capturing implicit access to semantic knowledge that occurs below the threshold of conscious awareness. As Dew and Cabeza (2011) have proposed, the border between explicit and implicit memory may be far more porous than has traditionally been thought; thus future research will help to better understand the relationship between implicit processing, feelings of familiarity, full recollection and partial recollection (purposeful and incidental).

The Distinctiveness of Partial Recollection and Implications for Theory

Current theories of recognition memory have been greatly influenced by past studies which have provided evidence for functional dissociations between cognitive processes. For instance, Rajaram (1993) provided evidence that "remember" and "know" responses operate differently based on manipulating levels of processing, such that "remember" responses increased for deep relative to shallow encoding whereas "know" responses increased for shallow relative to deep encoding. In another example, Gardiner and Parkin (1990) found that dividing attention during a recognition experiment by having individuals performing a simultaneous task at study reduced "remember" but not "know" responses. In yet another example, Yonelinas and Jacoby (1994) found that by increasing the length of a study list, recollection could be disrupted while familiarity remained intact. In order to understand the nature of the mechanisms involved in recognition, it is crucial to manipulate them experimentally to find fundamental differences between them. The present study provides several forms of evidence that partial recollection may in fact be fundamentally different than full recollection as well as familiarity that occurs in the absence of any recollection.

The first form of evidence involves the apparent scarcity of partial recollection across all experiments reported here. All participants experience some degree of full target recollection as well as instances of recollection failure in which no recollection of any verbalizable sort

occurred. However, many individuals in the present study did not demonstrate any partial recollection at all. If recollection and partial recollection were just differing degrees of the same process (i.e., strong vs. weak versions of the same continuous process), then presumably individuals who experienced full recollection would also experience partial recollection. This presumption in itself is not a functional dissociation, but rather it was a striking pattern that was consistent across all three experiments.

A functional dissociation was, however, demonstrated in Experiment 2. The behavior of full recollection and RWI differed significantly from that of partial recollection. That is, full recollection was greater for studied than nonstudied targets, and it was not impacted by manipulation of list type. RWI was affected by list-type (i.e., it was present for pure lists but absent for mixed lists). Partial recollection, on the other hand, was greater for *nonstudied* than studied targets, and it was impacted by list type in a different way (i.e., it was greater in mixed lists than in pure lists).

A second functional dissociation was found in Experiment 3. Full recollection was greater for studied neutral targets than studied emotional targets. RWI was also affected by emotion (the effect was present in the emotional condition but absent for the neutral condition). Partial recollection, on the other hand, was greater for *nonstudied* than studied targets, and it was impacted by emotion in a different way (i.e., it was greater for emotional targets than for neutral targets regardless of the study status of those targets).

These functional dissociations provide intriguing evidence that, unlike the predictions of the threshold DPSD model (e.g., Parks & Yonelinas, 2007), recollection may indeed be variable. This possibility is accounted for in a better way by other models such as the VRDP (e.g., Onyper et al., 2010). However even the VRDP does not explicitly predict that partial recollection should

behave in a distinct manner from full recollection. At the current time, perhaps network models such as the source-of-activation-confusion (SAC) model may provide the best account for the nature of recognition memory (e.g. Reder et al., 2000). However no models have specifically suggested that partial recollection may be a distinct entity.

On the Apparent Rarity of Partial Recollection

As evidenced across all three experiments in the present study, partial recollection (both purposeful and incidental) appears to be a rare phenomenon. It may be that typical list-learning paradigms in studies of recognition memory are not the appropriate means to study partial recollection. Moreover, many list-learning paradigms use word stimuli that have minimal contextual richness. Understanding when partial recollection is present and the conditions under which it is likely to occur may be important for recognition memory theory.

One possibility is that recollection, by and large, may operate in an all-or-none fashion most of the time in laboratory studies of recognition. If this is true, it is important to consider whether partial recollection really represents retrieval of details from the experimental study episode, or whether it could simply represent correct guessing influenced by activation that occurs below awareness. If full recollection occurs in a primarily all-or-none fashion in the laboratory, then certain models, like the DPSD model, may be correct for describing those types of data. However, it is possible that partial recollection occurs to a higher degree in real-life than in list-learning paradigms. A theoretically interesting follow-up to the present study would be to conduct survey research to document the frequency of partial recollection in the general population, as has been done to study such phenomena as déjà vu (e.g., Brown, 2004). It may be that partial recollection is a rare occurrence, even in day-to-day life. However, it may also be that recognition memory processes operate in a fundamentally different way inside the laboratory

(i.e., in list learning paradigms) than they do outside the laboratory, in which case, the mechanisms involved in day-to-day recognition may be far more dynamic than most current models acknowledge.

Modeling Partial Recollection

In the present study, partial recollection is consistent with the transition deficit (TD) model. The TD model suggests that TOTs in healthy populations result from a disruption in a relay of information from the lexical (i.e., semantic) level to the phonological level necessary for articulation (Burke, MacKay, Worthley, & Wade, 1991; James & Burke, 2000; Rastle & Burke, 1996; see Schwartz 2002 for a review). This view is also consistent with the type of disruption involved in anomic aphasia, such that if an anomic individual cannot retrieve a target, they can still generate partial information about it, or at very least, they experience a feeling that the target is present in memory. The fact that participants were sometimes able to identify the first letter, last letter, the number of syllables, or even a similar sounding word pertaining to a target suggests a mechanism involving spreading activation from node to node within a network of information.

The SAC model proposed by Reder and colleagues is one example of such a network model (e.g. Reder et al., 2000). In line with the SAC model, the present results suggest that below-threshold activation of a specific episode node, which contains the specific context associated with the experiment, may result in failure of full target retrieval while allowing *some* semantic and perceptual target information to leak into awareness. Also consistent with this view is that partial recollection also occurred in an incidental form as part of an incorrect initial answer. It is possible that retrieval of partial target information with awareness (i.e., when cued at test) results from a higher degree of network activation than incidental retrieval which may be

more implicit in nature. Also consistent with this view is that in the absence of any retrieval (full or partial), it is still possible to feel a target is familiar, which may be that a target is present in the network, yet activation is simply below the level necessary to evoke any retrieval.

Although the SAC model fits much of the data in the present study, it does not account for the patterns suggesting that partial retrieval is distinct from full retrieval as well as familiarity when all retrieval fails. No model of recognition memory to date has made this specific assumption, thus future work is needed to replicate these patterns and form a new connectionist model. It is possible that partial retrieval is dissociable in certain circumstances (e.g., with general semantic knowledge) while in others it is not.

Limitations and Future Directions

One limitation in Experiment 1 and 2 is the use of general knowledge questions from an aged database (Nelson & Narens, 1980). Although it is certainly advantageous to have normed stimuli for use across studies, future research should explore establishing a new set of general knowledge norms that are germane to modern participants. For example, in Experiment 3, a new set of stimuli were created using simple dictionary definitions. These stimuli were just as effective at eliciting partial recollection as those used by Nelson & Narens (1980), but they were not as reliant on historical facts whose relevance may degrade over time.

A second limitation in the present study was the simplicity of the perceptual information paired with to-be-remembered targets at encoding in Experiment 1. Future research should explore the role of more elaborate perceptual information at encoding to increase the likelihood of partial retrieval. Future research should also explore the role of repeated stimulus exposure (i.e., multiple encoding sessions) in order to facilitate binding of such perceptual information to targets. One possible way of increasing stimulus complexity while maintaining a high degree of

experimental control may be through the use of virtual reality to immerse participants in dynamic environments that more closely resemble those in the real world.

One additional promising direction for future research is to examine the neurological substrates of partial recollection as compared to full recollection and familiarity in the absence of any recollection in healthy young populations, healthy aging populations, and in aphasic populations. If these three states of memory are functionally dissociable in behavioral experiments, it is conceivable that they may be neurologically dissociable as well (cf. Daselaar, Fleck, & Cabeza, 2011). Additionally, exploring the role of semantic relationships with regard to partial recollection would be an intriguing future direction. Anecdotally, in the present study, participants were sometimes able to generate an incorrect answer that was semantically related to a target. Capturing these instances would provide unique insight into properties of information storage in the brain.

Finally, examining the relationship between partial recollections in relation to another rare memory state, déjà vu, may provide some insights into what factors elicit each and whether or not they have similar frequencies in the real world.

Conclusions

The present study has demonstrated evidence in support of partial recollection as a distinct entity in recognition memory using a novel experimental framework. Previous researchers have suggested that partial recollection may be inconsequential; however, I have provided evidence that partial recollection may indeed be of consequence. I have also provided evidence, using a novel method, that it is possible to parse it from full target recollection and familiarity in the absence of any recollection. It is my hope that this study will have provided a

step toward creating a unique bridge between the recognition memory, metacognition, anomic aphasia, emotion, and TOT literatures with regard to the nature of partial recollection.

References

Arndt, J., Lee, K. & Flora, D. B. (2008). Recognition without identification for words, pseudowords, and nonwords. *Journal of Memory and Language, 59*(3), 346-360.

Ashcraft, M.H. (1993). A personal case history of transient anomia. *Brain and Language, 44,* 47-57.

Badgaiyan, R.D. (2005) Conscious awareness of retrieval: An exploration of the cortical connectivity. *International Journal of Psychophysiology,* 55, 257-262.

Badgaiyan, R.D. and Posner, M.I. (1997) Time course of cortical activations in implicit and explicit recall. *Journal of Neuroscience,* 17, 4904-4913.

Balota, D.A., Yap, M.J., Cortese, M.J., Hutchison, K.A., Kessler, B., Loftis, B., Neely, J.H., Nelson, D.L., Simpson, G.B., & Treiman, R. (2007). The English Lexicon Project. Behavior Research Methods, 39, 445-459.

Bock, J. K. (1982). Toward a cognitive psychology of syntax: Information processing contributions to sentence formulation. Psychological Review, 89, 1-47.

Bowles, B., Crupi, C., Mirsattari, S. M., Pigott, S. E., Parrent, A. G., Pruessner, J. C., Yonelinas, A. P. & Kohler, S. (2007). Impaired familiarity with preserved recollection after anterior temporal-lobe resection that spares the hippocampus. *Proceedings of the National Academy of Sciences, 104,* 16382-16387.

Bowles, B., Crupi, C., Pigott, S., Parrent, A., Wiebe, S., Janzen, L., & Kohler, S. (2010). Double-dissociation of selective recollection and familiarity impairments following two different surgical treatments for temporal-lobe epilepsy. *Neuropsychologia, 48*(9), 2640-2647.

Bradley, M.M., & Lang, P.J. (1999). *Affective norms for English words (ANEW): Stimuli, instruction manual and affective ratings.* Technical report C-1, Gainesville, FL. The Center for Research in Psychophysiology, University of Florida.

Brown, A. S. (1991). A review of the tip-of-the-tongue experience. *Psychological Bulletin, 109*(2), 204-223.

Brown, A. S. (2004). *The déjà vu experience.* New York: Psychology Press.

Brown, A. S. (2012). *The tip of the tongue state*. New York: Psychology Press.

Brown, J., Lewis, V.J., & Monk, A.F. (1977). Memorability, word frequency, and negative recognition. *Quarterly Journal of Experimental Psychology, 29,* 461-473.

Brown, R., & McNeill, D. (1966). The “tip of the tongue”phenomenon. *Journal of Verbal Learning and Verbal Behavior, 5*, 325–337.

Buchanan TW, Tranel D, Adolphs R. (2005). Emotional autobiographical memories in amnesic patients with medial temporal lobe damage.J Neurosci, *23*(12), 3151-60.

Burke, D.M., MacKay, D.G., Worthley, J.S., & Wade, E. (1991). On the tip of the tongue: What causes word finding failures in young and older adults. *Journal of Memory and Language*, 30, 542-579.

Caramazza, A. (1997). How many levels of processing are there in lexical access? *Cognitive Neuropsychology, 14*(1), 177-208.

Cary, M., & Reder, L. M. (2003). A dual-process account of the list length and strength-based mirror effects in recognition. *Journal ofMemory & Language*, **49**, 231-248.

Carr, V.A., Rissman, J., & Wagner, A.D. (2010). Imaging the Human Medial Temporal Lobe with High-Resolution fMRI. *Neuron, 65,* 298-308.

Christianson, S. A. (1992). Emotional stress and eyewitness memory: A critical review. *Psychological Bulletin, 112,* 284–309.

Clark, S. E. & Burchett, E. R. (1994). Word frequency and list composition effects in associative recognition and recall. *Memory & Cognition, 22*(1), 55-62.

Clark, S.E., & Gronlund, S.D. (1996). Global matching models of recognition memory: How the models match the data. *Psychonomic Bulletin & Review, 3,* 37-60.

Cleary, A.M. (2004). Orthography, phonology, and meaning: Word features that give rise to feelings of familiarity in recognition. *Psychonomic Bulletin & Review, 11,* 446-451.

Cleary, A. M. (2005). ROCs in recognition with and without identification. *Memory, 5*, 472-483.

Cleary, A.M. (2006). Relating familiarity-based recognition and the tip-of-the-tongue phenomenon: detecting a word's recency in the absence of access to the word. *Memory & Cognition, 34*(4), 804-816.

Cleary, A.M., & Greene, R.L. (2000). Recognition without identification. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 26,* 1063-1069.

Cleary, A. M., & Greene, R. L. (2005). Recognition without perceptual identification: A measure of familiarity? *Quarterly Journal of Experimental Psychology, 58A,* 1143-1152.

Cleary, A. M., Langley, M. M., & Seiler, K. R. (2004). Recognition without picture identification: Geons as components of the pictorial memory trace. *Psychonomic Bulletin & Review, 11,* 903-908.

Cleary, A.M., & Reyes, N.L. (2009). Scene recognition without identification. *Acta Psychologia, 131*(1), 53-62.

Cleary, A.M., Ryals, A.J., & Nomi, J.S. (2009). Can déjà vu result from similarity to a prior experience? Support for the similarity hypothesis of déjà vu. *Psychonomic Bulletin & Review, 16*(6), 1082-1088.

Cleary, A.M., & Specker, L.E. (2007). Recognition without face identification. *Memory & Cognition, 35,* 1610–1619.

Cleary A.M,, Winfield, M.M., & Kostic, B. (2007). Auditory recognition without identification. *Memory & Cognition. 35*(8), 1869-77.

Cook, G. I., Marsh, R. L., & Hicks, J. L. (2006). Source memory in the absence of successful cued recall. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 32, 828-835.

Cotel, S., Gallo, D., & Seamon, J. **(**2008). Evidence that nonconscious processes are sufficient to produce false memories. *Consciousness and Cognition, 17* (1), 210-218.

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

Curran, T., & Cleary, A.M. (2003). Using ERPs to Dissociate Recollection from Familiarity in Picture Recognition. *Cognitive Brain Research, 15,* 191-205.

Daselaar, S. M., Fleck, M. S., & Cabeza, R. (2006). Triple dissociation within the medial temporal lobes: Recollection, familiarity, and novelty. *Journal of Neurophysiology*, 96, 1902-1911.

DeLosh, E. L., & McDaniel, M. A. (1996). The role of order information in free-recall: Application to the word frequency effect. *Journal of Experimental Psychology: Learning, Memory, & Cognition, 22, 1136-1146.*

Dew, I.T.Z. & Cabeza, R. (2011). The porous boundaries between explicit and implicit memory: behavioral and neural evidence. *Annals of the New York Academy of Sciences, 1224.*

Dewhurst**,** S.A. & Parry, L.A. (2000). Emotionality, Distintivness, and Recollective Experience. *European Journal of Cognitive Psychology*, *12*(4), 541-551.

Diana, R. Reder, L. M. Arndt, J., & Park, H. (2006). Models of recognition: A review of arguments in favor of a dual-process account. *Psychonomic Bulletin & Review, 13,* 1-21.

Diana, R.A., Yonelinas, A.P., & Ranganath, C. (2010). Medial temporal lobe activity during source retrieval reflects information type, not memory strength. *Journal of Cognitive Neuroscience, 22*(8), 1808-1818.

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

Dougal, S. & Rotello, C. M. (2007). "Remembering" emotional words is based on response bias, not recollection. *Psychonomic Bulletin and Review, 14(*3), 423.

Duncan, C.P. (1974). Retrieval of low-frequency words from mixed lists. *Bulletin of the Psychonomic Society, 4, 137–138.*

Dunn, J. A. (2004). RK: A matter of confidence. *Psychological Review*, 111, 524-542.

Francis D. R., Clark N., & Humphreys G. (2002) *Aphasiology, 16*(3), 243-259.

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

Gardiner, J.M., Gawlik, B., & Richardson-Klavehn, R. (1994). Maintenance rehearsal affects knowing, not remembering elaborative rehearsal affects remembering, not knowing. *Psychonomic Bulletin and Review*, 1, 107-110.

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

Gardiner, J.M. & Parkin, A.J. (1990). Attention and recollective experience in recognition memory. *Memory & Cognition, 18*(6), 579-583.

Glanzer, M., & Adams, J.K. (1985). The mirror effect in recognition memory, *Memory & Cognition, 13*(1), 8-20.

Glanzer, M., & Bowles N. (1976). Analysis of the word frequency effect in recognition memory. *Journal of Experimental Psycholog: Human Learning & Memory, 2*, 21-31.

Goldinger, S.D. & Hansen, W.A. (2005). Remembering by the seat of your pants. *Psychological Science,16*, 525.

Gollan, T. H., & Brown, A. S. (2006). From tip-of-the-tongue (TOT) data to theoretical implications in two steps: When more TOTs means better retrieval. *Journal of Experimental Psychology:General, 135*, 462–483.

Gorman, A. N. (1961). Recognition memory for names as a function of abstractness and frequency. *Journal of ExperimentalPsychology*, 61, 23-29.

Graf, P., & Schacter, D.L.(1985). Implicit and explicit memory for new associations in normal and amnesic subjects. J. Exp. Psychol. Learn Mem. Cogn. 11, 501–518.

Gregg, V. (1976). Word frequency, recognition and recall In J. Brown (Ed.), *Recall and recognition.* NewYork: Wiley.

Gruppuso, V., Lindsay, D., & Kelly, C. (1997). The process-dissociation procedure and similarity: Defining and estimating recollection and familiarity in recognition memory. *Journal of Experimental Psychology: Learning, Memory, & Cognition, 23*(2).

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

Harley, T. A. (2008). *The psychology of language* (3rd. ed.) Hove: Psychology Press.

Heuer, F. & Reisberg, D. (1990). Vivid memories of emotional events: The accuracy of remembered minutiae. *Memory and Cognition, 18*(5), 496.

Hicks, J.L., Marsh, R.L., & Ritschel, L. (2002). The Role of Recollection and Partial Information in Source Monitoring. *Journal of Experimental Psychology: Learning, Memory, and Cognition,28*(3), 503-508.

Hintzman, D.L. (1988). Judgments of frequency and recognition memory in a multiple-trace memory model. *Psychological Review, 95,* 528-551.

Hintzman D. L. & Curran, T. (1994). Retrieval dynamics of recognition and frequency judgments: Evidence for separate processes in familiarity and recall. *Journal of Memory and Language, 33*(1), 1-18.

Howard, M.W., Bessette-Symons, B., Zhang, Yaofei, & Hoyer, W.J. (2006). Aging selectively impairs recollection in recognition memory for pictures: Evidence from modeling and receiver operating characteristic curves. *Psychology and Aging, 21*(2), 96-106.

Jacoby, L. L. (1991). A process dissociation framework: Separating automatic from intentional uses of memory. *Journal of Memory and Language, 30*(5).

James, L. E., & Burke, D. M. (2000). Phonological priming effects on word retrieval and tip-of-the-tongue experiences in young and older adults. Journal of Experimental Psychology: *Learning, Memory, and Cognition, 26, 1378-1391.*

Johnson, M.K. (1997). Source monitoring and memory distortion. *Philosophical Transactions of the Royal Society of London B, 352,* 1733-1745.

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

Johnson, M.K., & Mitchell, K.J. (2002). Source Monitoring. In *Macmillan Psychology Reference Series, Volume 2: Learning and Memory (2nd ed.)* (pp. 628-631). New York: Macmillan Reference USA.

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

Jacoby, L. L. (1991). A process dissociation framework: Separating automatic from intentional uses of memory. *Journal of Memory and Language, 30*(5).

Kay, J. & Ellis, A. (1987). A cognitive neuropsychological case study of anomia. Implications for psychological models of word retrieval. *Brain, 110*(3), 613-629.

Kensinger E.A. (2009). *Emotional memory across the adult lifespan.* New York: Psychology Press.

Kensinger, E. A, & Corkin, S. (2003). Memory enhancement for emotional words: Are emotional words more vividly remembered than neutral words? *Memory & Cognition, 31*(8), 1169-1180.

Kensinger EA, Garoff-Eaton RJ, & Schacter DL (2006). Memory for specific visual details can be enhanced by negative arousing content. *Journal of Memory and Language, 54,* 99-112.

Kensinger, E.A., Piguet, O., Krendl, A.C., and Corkin, S. (2005) Memory for contextual details: Effects of emotion and aging. *Psychology and Aging*, 20, 241-250.

Koriat, A., & Levy-Sadot, R. (2001). The combined contributions of the cue-familiarity and accessibility heuristics to feelings of knowing. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 27*(1), 34-53.

Koriat. A., Levy-Sadot, R., Edry, E., & de Marcas, G. (2003). What do we know about what we cannot remember? Accessing the semantic attributes of words that cannot be recalled. *Journal of experimental Psychology: Learning, Memory and Cognition, 29*(6).

Kostic, B. & Cleary, A. M. (2009). Song recognition without identification: When people cannot "name that tune" but can recognize it as familiar. *Journal of Experimental Psychology: General, 138*(1), 146-159.

Lang, P.J., Bradley, M.M., & Cuthbert, B.N. (1990). Emotion, attention, and the startle reflex. *Psychological Review, 97*(3), 377-95. Levelt, W. J. M, Roelofs, A., & Meyer, A. S. (1999). A theory of lexical access in speech production. Behavioral and Brain Sciences, 22, 1–75.

Levelt, W. J. M. (1989). *Speaking: From intention to articulation.* Cambridge, MA: MIT Press.

Levelt, W.J.M. (1994). *On the skill of speaking: How do we access words?* Proceedings of the 2nd International Conference on Spoken Language Processing, 2253-2258.

Levelt, W.J.M. (1996). *A theory of lexical access in speech production.* Proceedings of the 16th conference on Computational Linguistics, 1, 3.

Levelt, W. J. M., Roelofs, A., & Meyer, A. (1999). A theory of lexical access in speech production. *Behavioral and Brain Sciences, 22,* 1-75.

Loftus, E.F. (1979). *Eyewitness Testimony.* Cambridge, MA: Harvard University Press.

Lopez Cutrin, B. & Vigliocco, G. (2007). Grammatical gender is everywhere, even on the tip of the mind: An investigation into retrieval failures. In Carson T. Schutze and Victor S. Ferreira (Eds.), *The State of the the Art in Speech Error Research: Proceedings of the LSA Institute Workshop. MIT Working Papers in Lingistics , 53,* 253-263.

Macho, S. (2004). Modeling associative recognition: a comparison of two-high-threshold, two-high-threshold signal detection, and mixture distribution models. *Journal of Experimental Psychology : Learning, Memory, and Cognition ,30,* 83–97.

Macleod, C.M. & Kampe, K.E. (1996). Word frequency effects on recall, recognition, and word fragment completion tests, *Journal of Experimental Psychology: Learning, Memory, & Cognition, 22*(1), 132-142.

Macmillan, N. A., & Creelman, C. D. (2005). Detection theory: A user's guide (2nd ed.). Mahwah, NJ: Erlbaum.

Mandler, G. (1980). Recognizing: The judgment of previous occurrence. *Psychological Review, 87,* 252-271.

Mandler, G., Pearlstone, Z., & Koopmans, H.S. (1969). Effects of organization and semantic similarity on recall and recognition. Journal of Verbal Learning and Verbal Behavior, *8*(3), 410-423.

Merriam-Webster's collegiate dictionary (11th ed.). (2005). Springfield, MA: Merriam-Webster.

Metcalfe, J. (1986). Feeling of knowing in memory and problem solving. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 12,* 288-294.

Metcalfe, J. (1993). Novelty monitoring, metacognition, and control in a composite holographic associative recall model: Implications for korsakoff amnesia. *Psychological Review, 100,* 3-22.

Metcalfe., J., Schwartz, B. L. & Joaquim, S. G. (1993). The cue-familiarity heuristic in metacognition. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 19,* 851-861.

Metcalfe, J. & Wiebe, D. (1987). Intuition in insight and noninsight problem solving. *Memory and Cognition, 15,* 238-246.

Mickes, L., Wixted, J. T., & Wais, P. (2007). A direct test of the unequal variance signal detection model of recognition memory. *Psychonomic Bulletin & Review,* 14, 858-865.

Mickley-Steinmetz, K.R., Addis, D. R., Kensinger, E. A. (2010). The effect of arousal on the emotional memory network depends on valence. *NeuroImage, 53,*, 318-324.

Milner, B. (2005). The Medial-Temporal Lobe Amnesic Syndrome. *Psychiatric Clinics of North America, 28* (3), 599-611.

Miozzo, M. & Caramazza, A. (1997a). On knowing the auxiliary of a verb that cannot be named: Evidence for the independence of grammatical and phonological aspects of lexical knowledge. *Journal of Cognitive Neuroscience, 9*, 160-166.

Miozzo, M. & Caramazza, A. (1997b). Retrieval of lexical-syntactic features in tip-of-the-tongue states. *Journal of Experimental Psychology: Learning Memory and Cognition, 23*, 1410-1423.

Mitchell, K.J., & Johnson, M.K. (2009). Source monitoring 15 years later: What have we learned from fMRI about the neural mechanisms of source memory? *Psychological Bulletin, 135*, 638-677.

Morin, C., Poirier, M., Portin, C., & Hulme, C. (2006). Word frequency and the mixed-list paradox in immediate and delayed serial recall. *Psychonomic Bulletin & Review, 4,* 724-729.

Nelson, T. O., & Narens, L. (1980). Norms of 300 general-information questions: Accuracy of recall, latency of recall, and feeling-of-knowing ratings. *Journal of Verbal Learning & Verbal Behavior*, 19, 338-368.

National Institute of Health (NIH) (2011). Definition of Anomic Aphasia retrieved from http://www.ninds.nih.gov/disorders/aphasia/aphasia.htm.

Ochsner, K. (2000). Are affective events richly recollected or simply familiar? The experience and process of recognizing feelings past. *Journal of Experimental Psychology: General, 129*, 242-261.

Onyper, S.V., Zhang, Y.X., & Howard, M. (2010). Some-or-None Recollection: Evidence from Item and Source Memory. *Journal of Experimental Psychology: General, 139*(2), 341-364.

Park, H., Arndt, J.D., & Reder, L.M. (2006). A contextual interference account of distinctiveness effects in recognition. Memory & Cognition, *34*(4), 743-75.

Park, H., Reder, L. M., & Dickison, D. (2005). The effects of word frequency and similarity on recognition judgments: The role of recollection. Journal of Experimental Psychology: Learning, Memory, and Cognition, *31*(3), 568–578.

Parks, C.M. (2007). The role of noncriterial recollection in estimating recollection and familiarity. *Journal of Memory and Language, 57*(1), 81-100.

Parks, C.M., DeCarli, C. Jacoby, L.L.M., & Yonelinas, A.P. (2010). Aging effects of recollection and familiarity: The role of white matter hyperintensitites. *Aging, Neuropsychology, and Cognition, 17*(4), 422-438.

Parks, C.M., Murray, Linda J., Elfman, K., & Yonelinas, A.P. (2011). Variations in recollection: The effects of complexity on source recognition. *Jouurnal of Experimental Psychology: Learning, Memory, & Cognition, 37*(4), 861-873.

Parks, C.M., & Yonelinas, A.P. (2007). Moving beyond pure signal-detection models: Comment on Wixted. *Psychological Review, 114,* 188-202.

Perfect, T. J., & Hanley, J. R. (1992). The tip-of-the-tongue phenomenon: Do experimenter-presented interlopers have any effect? *Cognition, 45,* 55–75.

Peynircioğlu, Z.F. (1990). Feeling-of-recognition without identification. Journal of Memory and Language, 29, 493-500.

Rajaram, S. (1993). Remembering and Knowing: Two means of access to the personal past. *Memory & Cognition, 21*(1), 89-102.

Rapp, B. & Goldrick, M. (2000). Discreteness and interactivity in spoken word production. *Psychological Review, 107,* 460-499.

Rastle, K.G., & Burke, D.M. (1996). Priming the tip of the tongue: Effects of prior processing on word retrieval in young and older adults. *Journal of Memory and Language, 35,* 586-605.

Reder, L.M. (2009). How Midazolam Can Help Us Understand Human Memory: 3 Illustrations and a Proposal for a New Methodology. In Proceedings of AMT. 2009.

Reder, L.M., Nhouyvanisvong, A., Schunn, C.D., Ayers, M.S., Angstadt, P, & Kazuo, H. (2000). A mechanistic account of the mirror effect for word frequency: A computational model of remember-know judgments in a continuous recognition paradigm. *Journal of Experimental Psychology: Learning, Memory, & Cognition, 26*(2), 294-320.

Reder, L.M., Proctor, I., Anderson, J.R., Gyulai, F., Quinlan, J.J., & Oates, J.M. (2006). Midazolam does not inhibit association formation, just its storage and strengthening. *Psychopharmacology, 188*(4), 462-471.

Reisberg, D. and Hertel, P., Editors (2004). *Memory and emotion.* New York: Oxford University Press.

Reyna, V.F., & Brainerd, C.J. (1995) Fuzzy trace theory: an interim synthesis. *Learning and Individual Differences, 7,* 1-75.

Roelofs, A. (1997a). The WEAVER model of word-form encoding in speech production. Cognition, 64, 249–284.

Roelofs, A. (1997b). Syllabification in speech production: Evaluation of WEAVER. Language and Cognitive Processes, 12, 659–696.

Rugg, M. D., & Curran, T. (2007). Event-related potentials and recognition memory. *Trends in Cognitive Sciences, 11,* 251-257.

Ryals, A.J., & Cleary, A.M. (2012). The Recognition without Cued Recall Phenomenon: Support for a Feature-Matching Theory over a Partial Recollection Account. *Journal of Memory and Language.* Doi: 10.1016/j.jml.2012.01.002.

Ryals, A.J., Yadon, C.A., Nomi, J.S., & Cleary, A.M. (2011). When word identification fails: ERP correlates of recognition without identification and of word identification failure. *Neuropsychologia, 49*(12), 3224-3237.

Schacter, D.L., Norman, K.A., & Koutstaal, W. (1998). The cognitive neuroscience of constructive memory. *Annual Review of Psychology,* 49, 289-318.

Schwartz, B. L. (1999). Sparkling at the end of the tongue: The etiology of tip-of-the-tongue phenomenology. *Psychonomic Bulletin and Review, 6,* 379 - 393.

Schwartz, B. L. (2002). *Tip-of-the-tongue states: Phenomenology, mechanism, and lexical retrieval*. Mahwah, NJ: Erlbaum.

Schwartz, B. L. (2008). Working memory load differentially affects tip-of-the-tongue states and feeling-of-knowing judgment. Memory & Cognition, 36, 9–19.

Schwartz, B. L. (2010). The effects of emotion on tip-of-the-tongue states. *Psychonomic Bulletin & Review. 17,* 82 – 87.

Schwartz, B. L., & Smith, S. M. (1997). The retrieval of related information influences tip-of-the-tongue states. *Journal of Memory and Language, 36,* 68-86.

Schwartz, B. L., & Metcalfe, J. (2011). Tip-of-the-tongue (TOT) states: Retrieval, Behavior, and Experience. *Memory & Cognition.* 39, 245-250.

Scoville, W.B. & Milner, B. (1957). Loss of Recent Memory After Bilateral Hippocampal Lesions. *Journal of Neurosurgery and Psychiatry*, *20*, 11.

Sharot T, Delgado MR, Phelps EA (2004). How emotion enhances the feeling of remembering *Nature Neuroscience, 7,* 1376–1380.

Sharot, T., Verfaellie, M., & Yonelinas, A.P. (2007). How Emotion Strengthens the Recollective Experience: A Time-Dependent Hippocampal Process. *PLoS One, 2*(10).

Sharot, T. Yonelinas A.P. (2008). Differential time-dependent effects of emotion on the recollective experience and memory for contextual information. *Cognition. 106* (1), 538 - 547.

Sherman, S.J., Atri, A., Hasselmo, M.E., Stern, C.E., Howard, M.W. (2003) Scopolamine impairs human recognition memory: Data and modeling. Behavioral Neuroscience, 117(3): 526-539.

Shiffrin, R. M., Ratcliff, R., & Clark, S. (1990). The list-strength effect. II. Theoretical mechanisms. *Journal of Experimental Psychology: Learning, Memory, & Cognition, 16,* 179-195.

Shiffrin, R.M. & Steyvers, M. (1997). A model for recognition memory: REM—Retrieving effectively from memory. *Psychonomic Bulletin & Review, 4*(2), 145-166.

Skinner, E. & Fernandes, M.A. (2010) Effect of study context on item recollection. *The Quarterly Journal of Experimental Psychology, 63*(7), 1318-1334.

Slotnick, S. D. (2010). R source memory ROCs indicate recollection is a continuous process. *Memory, 18,* 27–39.

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

Squire, L.R., Ojemann, J.G., Miezin, F.M., Petersen, S.E., Videen, T.O., Raichle, M.E., (1992). Activation of the hippocampus in normal humans: a functional anatomical study of memory. Proceedings of the National Academy of Sciences, 89, 1837–1841.

Toth, J., & Parks, C.M. (2006). Effects of age on estimated familiarity in the process-dissociation procedure: The role of noncriterial recollection. *Memory & Cognition, 34,* 527-537.

Tulving, E. (1985). Memory & Consciousness, *Canadian Psychology, 26,*1-12.

Turken, A.U. & Dronkers, N.F. (2011). The neural arthitecture of the language comprehension network: Converging evidence from lesion and connectivity analyses. *Frontiers in Systems Neuroscience, 5*(1).

Underwood, B. J., & Freund, J.S. (1970). Word frequency and short-term recognition memory. *American Journal of Psychology, 83*(3), 343-351.

Vigliocco, G., Antonini, T., & Garrett, M.F. (1997). Grammatical gender is on the tip of Italian tongues. *Psychological Science, 8,* 314-317.

Vigliocco, G., Vinson, D.P., Martin, R.C., & Garrett, M.F. (1999). Is "count" and "mass" information available when the noun is not? An investigation of tip of the tongue states and anomia. *Journal of Memory and Language, 40,* 534-558.

Voss, J.L., Lucas, H.D., & Paller, J.L. (2012). More than a feeling: Pervasive influences of memory processing without awareness of remembering. *Cognitive Neuroscience.*

Voss, J.L., & Paller, K.A. (2006). Fluent Conceptual Processing and Explicit Memory for Faces are Electrophysiolgically Distinct. *The Journal of Neuroscience, 26*(3), 926-933.

Voss, J.L. & Paller, K.A. (2009). An Electrophysiological Signature of Unconscious Recognition Memory. *Nature Neuroscience, (12)*3, 349-355.

Warrington E.K. & Weiskrantz , L. (1970). Amnesic syndrome: consolidation or retrieval. *Nature* 228, 628-630.

Warrington E.K. & Weiskrantz, L. (1974). The effect of prior learning on subsequent retention in amnesic patients. *Neuropsychologia*, 12, 419-28.

Watkins, M. J., LeCompte, D. C., & Kim, K. (2000). Role of study strategy in recall of mixed lists of common and rare words. *Journal of Experimental Psychology: Learning, Memory, & Cognition*, 26, 239-245.

Westerberg, C.E., Paller, K.A., Weintraub, S., Mesulam, M.-M, Holdstock, J.S., Mayes, A.R., & Reber, P.J. (2006). When memory does not fail: Familiarity-based recognition in mild cognitive impairment and Alzheimer's disease. *Neuropsychology, 20,* 193-205.

Wickens, C.D. (2002). Multiple resources and performance prediction. *Theoretical Issues in Ergonomics Science, 3*(2), 159-177.

Wixted, J.T. (2007a). Dual-process theory and signal-detection theory of recognition memory. *Psychological Review, 114,* 152-176.

Wixted, J.T. (2007b). Spotlighting the probative findings: A reply to Parks and Yonelinas (2007). *Psychological Review, 114,* 203-209.

Wixted, J.T., & Stretch, V. (2004). In defense of the signal detection interpretation of remember/know judgments. *Psychonomic Bulletin & Review, 11*(4), 616-641.

Yonelinas, AP (1994). Receiver operating characteristics in recognition memory: Evidence for a dual process model. Journal of Experimental Psychology: Learning, Memory, and Cognition, 20 (6), 1341-1354.

Yonelinas, A.P. (1997). Recognition memory for ROCs for item and associative information: The contribution of recollection and familiarity. *Memory & Cognition, 25*(6), 747-763.

Yonelinas, A.P. (2002). The nature of recollection and familiarity: A review of 30 years of research. *Journal of Memory and Language, 46,* 441-517.

Yonelinas, A.P. (2010). Recollection and Familiarity: Examining Controversial Assumptions and New Directions. *Hippocampus, 20,* 1178-1194.

Yonelinas, A.P. & Jacoby, L.L. (1994). Dissociating of processes in recognition memory: Effects of interference and of response speed. *Canadian Journal of Experimental Psychology.*

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

Appendix A. General knowledge questions and one-word answers from Nelson and Narens (1980) for use in Experiment 1.

Question	Answer
What is the proper name for a badminton bird?	shuttlecock
What is the name of the small Japanese stove used for outdoor cooking?	hibachi
What is the name of the collar bone?	clavicle
What is the name of the substance derived from a whale that is used in perfume?	ambergris
What is the last name of Dagwood's boss in the comic strip "Blondi"?	dithers
What is the name of the chapel whose ceiling was painted by Michelangelo?	sistine
What Italian city was destroyed when Mount Vesuvius Erupted in 79 A.D.?	pompeii
What is the name of the thick layer of fat on a whale?	blubber
What is the last name of the actor who platwed Rhett Butler in "Gone with the Wind?"	gable
What is the name of the ship that carried the pilgrims to America in 1620?	mayflower
What is the name of the large hairy spider that lives near bananas?	tarantula
What is the name for the astronomical bodies that enter the Earth's atmosphere?	meteors
What is the name of the spearlike object that is thrown during a track meet?	javelin
What is the name of the first artificial satellite put in orbit by Russia in 1957?	sputnik
What is the name of the Roman emperor who fiddled while Rome burned?	nero
What kind of poison did Socrates take at his execution?	hemlock
What is the name of deer meat?	venison
What was the last name of the criminal known as Scarface?	capone
What is the name of the mountain range in which Mount Everest is located?	himalayas
What is the unit of sound intensity?	decibel
What is the only word the raven says in Edgar Allen Poe's "The Raven?"	nevermore
What is the name of an illegal move by a baseball pitcher that results in all runners advancing one base?	balk
What is the last name of the astronomer who published his theory that the Earth revolves around the sun in 1543?	copernicus
What is the name of the mansion in Virginia that was home to Thomas Jefferson?	monticello
What is the last name of the scientist who discovered radium?	curie
What is the last name of the man who first studied genetic inheritance in plants?	mendel
What is the name of the lightest wood known?	balsa
What is the name of the furry animal that attacks cobra snakes?	mongoose
What is the last name of the man who wrote "Canterbury Tales?"	chaucer
What is the last name of the commander who lost the battle of the Little Bighorn River?	custer
What is the name of the Chinese religion founded by Lao Tse?	taoism
What is the name of Germany's largest battleship that was sunk during WWII?	bismarck
What is the name of the short pleated skirt worn by men in Scotland?	kilt
What is the name of the bird that cannot fly and is the largest bird on Earth?	ostrich
What is the name of the submarine in Jules Verne's "2000 Leagues beneath the sea?"	nautilus
What animal runs the fastest?	cheetah
What is the name of the Three-Leaf Clover that is the emblem of Ireland?	shamrock
What is the last name of the famous magician and escape artist who died of appendicitis?	houdini
What is the last name of the man who rode horseback in 1775 to warn that the British were coming?	revere
What is the name of the organ that produces insulin?	pancreas
What is the name of the North Star?	polaris

What is the term in golf referring to a score one under par on and particular hole?	birdie
What is the name of the severe headache that returns periodically and often is accompanied by nausea?	migraine
What is the name of the largest desert on Earth?	sahara
What is the name of an inability to sleep?	insomnia
Who is known as "The father of Geometry?"	euclid
What is the name of a dried plum?	prune
What is the name of the crime in which a building or property is purposely set on fire?	arson
What is the name of the supposedly unsinkable ship that sunk on its maiden voyage in 1912?	titanic
What is the palace built in France by King Louie XIV	versailles
What is the last name of the author who wrote "Brave New World?"	huxley
What is the name of Dorothy's dog in "The Wizard Of OZ"?	toto
What is the last name of the author who wrote "Oliver Twist"?	dickens
What is the last name of the author of the book "1984"	orwell
What sport uses the terms "brooms" and "stones"?	curling
In which game are men crowned?	checkers
What is the name of the remains of plants and animals that are found in stone?	fossils
What is the name of the hillbilly family that had a famous feud with the MCCoy family?	hatfield
In which type of ski race does the downhill skier make sharp turns around poles?	slalom
What is the last name of the singer who recorded "Heartbreak Hotel" and "All Shook up"?	presley
Which breed of cat has blue eyes?	siamese
In which city is the U.S. Naval Academy Located?	annapolis
What is the last name of the first signer of the "Declaration of Independence"	hancock
What is the name of the kind of cat that spoke to Alice in the story "Alice's Adventures in Wonderland?"	cheshire
What is the name of the city in Italy that is known for its canals?	venice
What is the name of the legendary one-eyed giant in Greek mythology?	cyclops
Of which country is Nairobi the capitol?	kenya
In which sport does a rider on horseback hit a ball with his mallet?	polo
What is the capitol of Delaware?	dover
What is the longest river in South America?	amazon
In which city is Michelangelo's statue of David located?	florence
What is the last name of the author who wrote under the pseudonym of Mark Twain?	clemens
What is the name of the crime in which a person purposely betrays his country?	treason
Which game uses a doubling cube?	backgammon
What is the name of a cyclone that occurs over land?	tornado
What game uses a rubber ball and little metal pieces?	jacks
What is the name of the navigation instrument used at sea to plot position relative to the magnetic north pole?	compass
What is the name of Socrates' most famous student?	plato
What is the name of the lizard that changes its color to match the surroundings?	chameleon
What is the name of an airplane without an engine?	glider
What is the name of the extinct reptiles known as "terrible lizards"?	dinosaurs
What is the last name of the composer who wrote the opera "Don Giovanni?"	mozart
What is the last name of the man who was President directly after James Madison?	monroe
What is the last name of the man who began the reformation in Germany?	luther
What is the name of the desert people who wander instead of living in one place?	nomads

What is the capitol of Denmark?	copenhagen
What is the name for a medical doctor who specializes in cutting the body?	Surgeon
What is the last name of the actress who received the best actress award for the movie "Mary Poppins?"	andrews
What is the last name of the author who wrote "Romeo and Juliet"?	shakespeare
What is the largest planet in the solar system?	jupiter
What is the capital city of New York?	albany
Which type of snake do asian snake charmers use?	cobra
What is the last name of the first person to set foot on the moon?	armstrong
What is the name of a giant ocean wave caused by an earthquake?	tidal
What is the name of the poker hand in which all of the cards are of the same suit?	flush
What is the term for hitting a volleyball down hard into the opponent's court?	spike
Over which river is the George Washington Bridge?	hudson
What is the last name of the man who assassinated Abraham Lincoln?	booth
What precious gem is red?	ruby
What is the name of the project which developed the atomic bomb during World War II?	manhattan
Of which country is Buenos Aires the capitol?	argentina
Of which country is Budapest the capitol?	hungary
In what European city is the Parthenon located?	athens
What is the last name of the man who proposed the theory of relativity?	einstein
What sport uses the terms "gutter" and "alley"?	bowling
What is the name of the island-city believed since antiquity to have sunk into the ocean?	atlantis
What is the name of the liquid portion of whole blood?	plasma
In what ancient city were the famous "Hanging Gardens" located?	babylon
What is the last name of the man who showed that lightning is electricity?	franklin
What is the capitol of Russia?	moscow
What was the name of the Apollo lunar module that landed the first man on the moon?	eagle
What is the only liquid medal at room temperature?	mercury
What is the last name of the boxer who later became known as Mohammud Ali?	clay
In which sport is the stanley cup awarded?	hockey
What is the last name of the second U.S. President?	adams
In which city does the Cotton Bowl take place?	dallas
For which country is the rupee the monetary unit?	india
Who was the leader of the Argonauts?	jason
For which country is the yen the monetary unit?	japan
What was the name of the union iron-clad ship that fought the confederate Ironclad Merrimack?	monitor

Appendix B. Descriptive statistics for incidental partial retrieval in Experiment 1.

Mean Proportion of Incidental Partial Retrieval by Complexity Level for Experiment 1.

(Complexity Level)	Mean	(SD)
Nonstudied	.03	*(.02)*
Level 1	.03	*(.04)*
Level 2	.03	*(.04)*
Level 3	.03	*(.04)*

Mean Recognition Ratings for Incidental Retrieval by Complexity for Experiment 1.

(Complexity Level)	Mean	(SD)
Nonstudied	3.20	*(2.49)*
Level 1	5.52	*(3.64)*
Level 2	4.17	*(3.41)*
Level 3	6.10	*(3.38)*

Appendix C. Mean recognition ratings for partial contextual and target-related retrieval from Experiment 1.

Mean Recognition Ratings for Retrieval of Partial Target-Related Information when Full Target Retrieval Fails for Nonstudied and Studied Targets in Experiment 1

(Complexity Level)	Mean	(SD)
New (nonstudied)	2.72	*(1.32)*
Level 1	6.06	*(3.44)*
Level 2	3.43	*(2.44)*
Level 3	5.28	*(2.13)*

Mean Recognition Ratings for Retrieval of Partial Contextual information Accompanying Studied Retrieved and Studied Unretrieved Targets.

	Studied Retrieved		Studied Unretrieved	
(Complexity Level)	Mean	(SD)	Mean	(SD)
Level 1	8.99	(*2.09)*	6.06	*(3.44)*
Level 2	7.77	*(2.44)*	6.19	*(4.15)*
Level 3	9.37	*(1.64)*	8.69	*(1.85)*

Appendix D. General knowledge questions and one-word answers from Nelson and Narens (1980) separated into high and low frequency lists for Experiment 2.

High Frequency List from Experiment 2

Question	Answer
Which breed of cat has blue eyes?	siamese
In which city is the U.S. Naval Academy Located?	annapolis
What is the last name of the first signer of the "Declaration of Independence"	hancock
What is the name of the kind of cat that spoke to Alice in the story "Alice's Adventures in Wonderland?"	cheshire
What is the name of the city in Italy that is known for its canals?	venice
What is the name of the legendary one-eyed giant in Greek mythology?	cyclops
Of which country is Nairobi the capitol?	kenya
In which sport does a rider on horseback hit a ball with his mallet?	polo
What is the capitol of Delaware?	dover
What is the longest river in South America?	amazon
In which city is Michelangelo's statue of David located?	florence
What is the last name of the author who wrote under the pseudonym of Mark Twain?	clemens
What is the name of the crime in which a person purposely betrays his country?	treason
Which game uses a doubling cube?	backgammon
What is the name of a cyclone that occurs over land?	tornado
What game uses a rubber ball and little metal pieces?	jacks
What is the name of the navigation instrument used at sea to plot position relative to the magnetic north pole?	compass
What is the name of Socrates' most famous student?	plato
What is the name of the lizard that changes its color to match the surroundings?	chameleon
What is the name of an airplane without an engine?	glider
What is the name of the extinct reptiles known as "terrible lizards"?	dinosaurs
What is the last name of the composer who wrote the opera "Don Giovanni?"	mozart
What is the last name of the man who was President directly after James Madison?	monroe
What is the last name of the man who began the reformation in Germany?	luther
What is the name of the desert people who wander instead of living in one place?	nomads
What is the capitol of Denmark?	copenhagen
What is the name for a medical doctor who specializes in cutting the body?	surgeon
What is the last name of the actress who received the best actress award for the movie "Mary Poppins?"	andrews
What is the last name of the author who wrote "Romeo and Juliet"?	shakespeare
What is the largest planet in the solar system?	jupiter
What is the capital city of New York?	albany
Which type of snake do Asian snake charmers use?	cobra
What is the last name of the first person to set foot on the moon?	armstrong
What is the name of a giant ocean wave caused by an earthquake?	tidal
What is the name of the poker hand in which all of the cards are of the same suit?	flush
What is the term for hitting a volleyball down hard into the opponent's court?	spike
Over which river is the George Washington Bridge?	hudson
What is the last name of the man who assassinated Abraham Lincoln?	booth

What precious gem is red?	ruby
What is the name of the project which developed the atomic bomb during World War II?	manhattan
Of which country is Buenos Aires the capitol?	argentina
Of which country is Budapest the capitol?	hungary
In what European city is the Parthenon located?	athens
What is the last name of the man who proposed the theory of relativity?	einstein
What sport uses the terms "gutter" and "alley"?	bowling
What is the name of the island-city believed since antiquity to have sunk into the ocean?	atlantis
What is the name of the liquid portion of whole blood?	plasma
In what ancient city were the famous "Hanging Gardens" located?	babylon
What is the last name of the man who showed that lightning is electricity?	franklin
What is the capitol of Russia?	moscow
What was the name of the Apollo lunar module that landed the first man on the moon?	eagle
What is the only liquid medal at room temperature?	mercury
What is the last name of the boxer who later became known as Muhammed Ali?	clay
In which sport is the Stanley cup awarded?	hockey
What is the last name of the second U.S. President?	adams
In which city does the Cotton Bowl take place?	dallas

Low Frequency List from Experiment 2

What is the technical term for a badminton birdie?	shuttlecock
What is the name of the small Japanese stove used for outdoor cooking?	hibachi
What is the name of the collar bone?	clavicle
What is the name of the substance derived from a whale that is used in perfume?	ambergris
What is the last name of Dagwood's boss in the comic strip "Blondi"?	dithers
What is the name of the chapel whose ceiling was painted by Michelangelo?	sistine
What Italian city was destroyed when Mount Vesuvius Erupted in 79 A.D.?	pompeii
What is the name of the thick layer of fat on a whale?	blubber
What is the last name of the actor who played Rhett Butler in "Gone with the Wind?"	gable
What is the name of the ship that carried the pilgrims to America in 1620?	mayflower
What is the name of the large hairy spider that lives near bananas?	tarantula
What is the name for the astronomical bodies that enter the Earth's atmosphere?	meteors
What is the name of the spearlike object that is thrown during a track meet?	javelin
What is the name of the first artificial satellite put in orbit by Russia in 1957?	sputnik
What is the name of the Roman emperor who fiddled while Rome burned?	nero
What kind of poison did Socrates take at his execution?	hemlock
What is the name of deer meat?	venison
What was the last name of the criminal known as Scarface?	capone
What is the name of the mountain range in which Mount Everest is located?	himalayas
What is the unit of sound intensity?	decibel

What is the only word the raven says in Edgar Allen Poe's "The Raven?"	nevermore
What is the name of an illegal move by a baseball pitcher that results in all runners advancing one base?	balk
What is the last name of the astronomer who published his theory that the Earth revolves around the sun in 1543?	copernicus
What is the name of the mansion in Virginia that was home to Thomas Jefferson?	monticello
What is the last name of the scientist who discovered radium?	curie
What is the last name of the man who first studied genetic inheritance in plants?	mendel
What is the name of the lightest wood known?	balsa
What is the name of the furry animal that attacks cobra snakes?	mongoose
What is the last name of the man who wrote "Canterbury Tales?"	chaucer
What is the last name of the commander who lost the battle of the Little Bighorn River?	custer
What is the name of the Chinese religion founded by Lao Tse?	taoism
What is the name of Germany's largest battleship that was sunk during WWII?	bismarck
What is the name of the short pleated skirt worn by men in Scotland?	kilt
What is the name of the bird that cannot fly and is the largest bird on Earth?	ostrich
What is the name of the submarine in Jules Verne's "2000 Leagues beneath the sea?"	nautilus
What animal runs the fastest?	cheetah
What is the name of the Three-Leaf Clover that is the emblem of Ireland?	shamrock
What is the last name of the famous magician and escape artist who died of appendicitis?	houdini
What is the last name of the man who rode horseback in 1775 to warn that the British were coming?	revere
What is the name of the organ that produces insulin?	pancreas
What is the name of the North Star?	polaris
What is the term in golf referring to a score one under par on and particular hole?	birdie
What is the name of the severe headache that returns periodically and often is accompanied by nausea?	migraine
What is the name of the largest desert on Earth?	sahara
What is the name of an inability to sleep?	insomnia
Who is known as "The father of Geometry?"	euclid
What is the name of a dried plum?	prune
What is the name of the crime in which a building or property is purposely set on fire?	arson
What is the name of the supposedly unsinkable ship that sunk on its maiden voyage in 1912?	titanic
What is the palace built in France by King Louie XIV	versailles
What is the last name of the author who wrote "Brave New World?"	huxley
What is the name of Dorothy's dog in "The Wizard Of OZ"?	toto
What is the last name of the author who wrote "Oliver Twist"?	dickens
What is the last name of the author of the book "1984"	orwell
What sport uses the terms "brooms" and "stones"?	curling
In which game are men crowned?	checkers

Appendix E. Descriptive statistics for incidental partial retrieval in Experiment 2.

Mean Proportion of Incidental Partial Retrieval by Study Status, List-Type, and Frequency of Targets for Experiment 2.

		Studied	Nonstudied
(List-Type)	(Freq)	Mean (*SD*)	Mean (*SD*)
Mixed	HF	.04 *(.05)*	.07 *(.05)*
	LF	.03 *(.04)*	.05 *(.05)*
Pure	HF	.05 *(.04)*	.06 *(.04)*
	LF	.03 *(.03)*	.04 *(.04)*

Mean Recognition Ratings for Incidental Retrieval by List-Type, Frequency, and Study Status For Experiment 2.

		Studied	Nonstudied
(List-Type)	(Freq)	Mean (*SD*)	Mean (*SD*)
Mixed-list	HF	3.02 *(2.43)*	3.50 *(3.01)*
	LF	6.08 *(5.09)*	4.58 *(3.00)*
Pure-List	HF	4.91 *(3.59)*	2.45 *(1.45)*
	LF	5.10 *(2.99)*	3.88 *(2.63)*

Appendix F. Mean recognition ratings for partial retrieval in Experiment 2.

Mean Recognition Ratings Given to Questions Eliciting Partial Retrieval by Study Status, List-Type and Frequency for Experiment 2.

		Studied	Nonstudied
(List-Type)	(Freq)	Mean (*SD*)	Mean (*SD*)
Mixed-list	HF	2.33 *(2.31)*	6.17 *(3.40)*
	LF	2.17 *(2.02)*	4.33 *(1.46)*
Pure-List	HF	4.00 *(3.00)*	4.13 *(1.46)*
	LF	5.00 *(1.00)*	4.67 *(3.05)*

Appendix G. General knowledge questions separated into emotional and neutral lists for Experiment 3.

Emotional List (Negative/Arousing)

What is another term for "misuse or use wrongly"?	abuse
When something is not done on purpose it is said to be what?	accident
What is another way of saying apprehensive or fearful?	afraid
What is a feeling of displeasure resulting from injury?	anger
What is also known as a violent attack that can be either verbal or physical?	assault
A person legally unable to pay his or her debts is known as what?	bankrupt
To help one's enemy is to do what to your friends?	betray
What is an explosive, chemical, or incendiary device used to cause destruction?	bomb
What is the name of the constellation of stars shaped like a crab?	cancer
What is the term for a particular kind of cymbals used in a marching band?	crash
To execute someone by affixing them to a cross and leaving them to die by exposure is to do what?	crucify
What is the name for an evil spirit believed by some to be involved in possession?	demon
When you look down on someone with contempt and scorn, you are said to do what?	despise
What is another name for when you dislike something intensely?	detest
What entity is thought by some to be the chief supernatural spirit and foe of God?	devil
What is also known as a happening that causes great harm or damage?	disaster
A person who fails to be faithful to a person, country, or body to whom they have obligations is what?	disloyal
What is also known as the state of being in pain, suffering, or anxiety?	distressed
What is the formal and legal dissolution of a marriage called?	divorce
To die by suffocation in water or other liquid is to do what?	drown
The state of being afraid may also be known as the state of being what?	fearful
The emotion characterized by a strong sense of dislike or ill will towards someone or something is known as what?	hate
Having the emotion characterized by a strong sense of dislike or ill will towards someone is to have what toward them?	hatred
What is the term for a person who is taken prisoner by an enemy until certain demands are met?	hostage
To hurt the pride of or dignity of someone (often publicly) is to do what to them?	humiliate
What is also known as the act of treating or speaking to someone with scorn or disrespect?	insult
What is another name for murderer?	killer
What is the chronic infections disease known since biblical times caused by bacteria that causes deformation?	leprosy
Someone who commits the unlawful and malicious act of taking another's life is also known as what?	murderer
To damage, injure or otherwise make imperfect something is to do what to it?	mutilate
What is another name for a sleep state that is accompanied by a sensation of oppression and hopelessness?	nightmare
What is the term for the sensation of hurting or strong discomfort?	pain
What is a substance that causes illness or death when consumed?	poison
To make something unclean, impure, or corrupt is to do what to it?	pollute
What is the name of the infectious disease transmitted to humans by animals resulting in the inability to drink liquids?	rabies
Something that has been refused, deemed useless, or discarded as worthless has been what?	rejected

What is another term for the butt of a marijuana cigarette?	roach
The killing or butchering of animals for food is also known as what?	slaughter
A human being who is owned as property by another and is completely subject to their will is known as what?	slave
Mental or physical tension or strain is also known as what?	stress
To kill someone or something by cutting off the supply of oxygen to the lungs or gills is known as what?	suffocate
What is another word for very bad, unpleasant, or extreme?	terrible
Someone who is frightened greatly could also be said to be what?	terrified
Who is someone who uses violence, force, or threats to demoralize and intimidate people?	terrorist
What is another name for someone who steals?	thief
The act of inflicting severe mental or physical pain to force information or confession is also known as what?	torture
If something is poisonous or harmful to the environment or living creatures it is said to be what?	toxic
What is the name of a serious play that typically deals with the problems of a central character?	tragedy
A painful emotion experience, often causing a lasting psychological effect, is known as what?	trauma
Someone who is disturbed, worried, or experiencing mental discomfort is said to be what?	troubled
A mass of new tissue growth independent of its surround structures is known as what?	tumor
What is the name of an open sore on the lining of the stomach?	ulcer
To be guilty of adultery is also known as being what?	unfaithful
A person who suffers some loss or crime against them is also known as what?	victim
someone who acts with great physical force so as to injure or destroy is said to be what?	violent
What is another name for an armed battle or conflict between two factions?	war

Neutral List

Someone who is overly willing to start a fight or a quarrel could be called what?	aggressive
What is the term for someone who is not a legal citizen of a given country or region?	alien
What is term for sports, games, or activities requiring physical activity?	athletics
What is the name for a method of cooking food by subjecting it to dry heat in an oven?	bake
What is another name for a liquid made for drinking other than water?	beverage
What is the name of a large piece of artillery commonly used in the Civil war?	cannon
A high steep face of a rock, especially on the coast, is known as what?	cliff
Someone who lacks grace or skill and is awkward with their hands and feet could be called what?	clumsy
What is the term used for a temperature much lower than that of the human body?	cold
To collect or focus one's thoughts or efforts is to do what?	concentrate
What is the name of everything that can be inside of a container?	contents
Someone who is eager to learn or know could be called what?	curious
A usual practice of behaving in a given culture is known as what?	custom
Someone who is openly and boldly resistant to something could be called what?	defiant
What is the name of a person whose primary profession is the care of teeth and surrounding tissues?	dentist
What is the name of a person who is licensed to practice the healing arts?	doctor
A material made by combining fibers through means such as weaving is known as what?	fabric

The whitish mass of bubbles on or in liquids due to agitation is called what?	foam
What is the name of a tool used for pounding usually fastened at one end of a wooden stick?	hammer
A large bird of prey characterized by short rounded wings, a hooked beak, and claws is a what?	hawk
What is a word meaning to keep secret or out of sight?	hide
Any public road freely open to anyone is known as a what?	highway
Institution where the ill, infirmed, orphaned, and injured receive rest and care is a what?	hospital
What is the name of a thin oil distilled petroleum used as a fuel or illuminant?	kerosene
A story handed down by generations believed to have a historical basis is known as what?	legend
What is the name of a large powerful member of the cat family often found in Africa?	lion
The science of diagnosing, treating, and curing and preventing disease is called what?	medicine
What is the power, act, or process of bringing to mind events previously experienced?	memory
Something that is remarkable large, strong, and powerful might be said to be what?	mighty
What is the term that means an act or tendency to annoy or vex with playful tricks?	mischief
What is a word used to describe someone who is very strong and well-built?	muscular
To be completely bare, unclothed, or uncovered is to be what?	naked
What is the name of something that makes more sound than is normal or customary?	noisy
The state of being overly focused on a particular thought, person, or item is known as what?	obsession
A narrow alley, tunnel, hall, or corridor meant for travel is known as what?	passage
What is the name of a person who loyally or zealously loves their own country?	patriot
What is the name of a carpenter’s tool used for shaving a wood surface to make it level?	plane
What is the name for a sharp-edge cutting instrument used for shearing or cutting off all hair?	razor
The state of being uneven, bumpy, abrasive, or wooly might be called what?	rough
The act of greeting with a friendly and ceremonial gesture is known as what?	salute
What is the name of a smoothbore gun used for firing small metal pellets at a short range?	shotgun
What is another name for a very tall building?	skyscraper
Something that is even and level surface with no roughness or projections is said to be what?	smooth
What is the name of an atmospheric disturbance usually accompanied by high wind and rain?	storm
What is another term for a wet spongy piece of land like a marsh or a bog?	swamp
If someone is capable of moving with great speed and agility, they may be said to be what?	swift
What is it called when you purposefully meddle with something so as to damage it?	tamper
What is the term that means to experience the flavor of something?	taste
To harass or make fun of by constantly annoying or poking playful fun at someone is to do what?	tease
What is the name for a brass instrument with a blaring tone and only three keys?	trumpet
A large reinforced box for carrying a traveler's clothing and possessions is known as what?	trunk
What is the name of a vent in the earth's crust through which molten lava flows?	volcano
A relatively long journey or passage by water is also known as what?	voyage
What is the feeling of awe, astonishment, or admiration due to something unexpected and strange?	wonder
What is the name of person whose occupation is creating works for publication?	writer
Gold, butter, and lemons might all be said to be what particular hue?	yellow

Appendix H . Descriptive statistics for incidental partial retrieval in Experiment 3.

Mean Proportion of Incidental Partial Retrieval by Study Status and Emotion for Experiment 3.

	Studied	Nonstudied
(Emotion)	Mean (*SD)*	Mean (*SD)*
Neutral	.05 *(.04)*	.07 *(.05)*
Emotional	.09 *(.06)*	.10 *(.06)*

Mean Recognition Ratings for Incidental Partial Retrieval by Study Status and Emotion for Experiment 3.

	Studied	Nonstudied
(Emotion)	Mean (*SD)*	Mean (*SD)*
Netural	3.97 *(2.52)*	2.99 *(2.31)*
Emotional	5.01 *(2.44)*	3.69 *(2.28)*

Appendix I. Mean recognition ratings for partial retrieval in Experiment 3.

Mean Recognition Ratings for Partial Retrieval
by Study Status and Emotion for Experiment 3.

	Studied	Nonstudied
(Emotion)	Mean (*SD*)	Mean (*SD*)
Netural	3.90 *(2.18)*	2.93 *(2.19)*
Emotional	5.11 *(2.75)*	3.53 *(1.80)*