THESIS

THE EXPERIENCE OF NOVELTY: ANOTHER DIMENSION TO SUBJECTIVE MEMORY EXPERIENCES?

Submitted by

Shelly Staley

Department of Psychology

In partial fulfillment of the requirements

For the Degree of Master of Science

Colorado State University

Fort Collins, Colorado

Spring 2014

Master's Committee:

Advisor: Anne Cleary

Carol Seger
Kim Hoke

ABSTRACT

THE EXPERIENCE OF NOVELTY: ANOTHER DIMENSION TO SUBJECTIVE MEMORY EXPERIENCES?

Subjective experiences of memory (e.g., feelings of familiarity) have been a topic of much research. Though novelty might be considered a manifestation of memory (insofar as some form of memory for the past is required in order for novelty recognition or detection to occur), subjective experiences of novelty have largely been ignored in the current memory literature. The present study used a rating scale to measure the subjective feeling of novelty. One goal was to investigate potential mechanisms of feelings of novelty. Another was to determine how feelings of novelty relate to feelings of familiarity; for example, many models assume that novelty is simply the inverse of familiarity. Two experiments reported here examined if this presumed relationship between familiarity and novelty is an accurate assumption. In one experiment, subjects viewed words in a study list and then were tested on cues that potentially shared orthographic features with the study words while duration of cue-prime exposure and cue-match-priming effects were observed. In another, subjects were tested after having repeated the test cues aloud either once or 30 times. Both experiments compared a familiarity rating scale with a novelty rating scale. No effects of duration of exposure (either through priming in Experiments 1 and 2 or repetitions in Experiment 3) were observed, helping to rule out several potential mechanisms of feelings of novelty. Differences in how familiarity ratings and novelty ratings responded to the experimental manipulations were found in both experiments, suggesting that the sense of novelty is not simply the inverse of familiarity.

TABLE OF CONTENTS

ABSTRACT ii
INTRODUCTION 1
EXPERIMENT 1: A PILOT INVESTIGATION 27
EXPERIMENT 2 39
EXPERIMENT 3 53
GENERAL DISCUSSION 69
REFERENCES 113

INTRODUCTION

Throughout the span of human history our ability to survive has been dependent upon our capacity to adapt to our environment and respond to whatever situation we may be faced with. This ability translates into our ability to learn and, in order to do this, we must be able to discriminate between those situations in which we already have a pattern to drive our response and those situations which may be new, where no pattern exists. When we are faced with a situation that we have been in before, we can rely on our experiences of that past event to predict what that situation will entail and to employ the appropriate response patterns (See Glenberg, 1997). We are motivated to learn in order to improve upon these predictions so that we can become more efficient and effective in our environment. We seek out novel experiences to facilitate this learning. Though much research exists on the importance of novelty in learning and memory processes, little is known about the subjective experience of novelty itself. A great deal of research exists on other subjective experiences of memory, such as tip-of-the-tongue-experiences (e.g., see Schwartz, 2002, for a review), feelings of familiarity (e.g., Mandler, 2008; Yonelinas, 2002), feelings of knowing (e.g., Koriat & Leiblich, 1977), and even déjà vu experiences (e.g., Brown & Marsh, 2010; Cleary, 2008; Cleary, Ryals & Nomi, 2009; Cleary et al., 2012), but little is known about the subjective experience of novelty. The purpose of the present study is to examine several hypotheses related to the subjective experience of novelty.

What is Novelty?

There is variability within the literature as to what actually constitutes novelty. While the most common use of the term may apply it to items or situations that are completely new or never before seen, other definitions exist within different research paradigms. Four types of novelty will be discussed below: stimulus novelty, contextual novelty, associative novelty and novelty as lack of earlier occurrence in a list. All of these types of novelty will be discussed in relation to the literature and throughout this paper.

Novelty as Stimuli Never Before Seen

Stimulus novelty refers to enhanced processing for new items compared to that elicited upon repetition of a stimulus. This is analogous to the idea of priming, where the presentation of a stimulus, such as a word, elicits different responses upon multiple presentations. Novelty can be thought of here as a characteristic of the stimulus itself by which there are differing degrees of novelty depending on the amount of prior exposure to that stimulus. This definition of novelty would encompass items or stimuli that have never been seen before as well as those that have been seen but are relatively rare or uncommon occurrences (Ranganath & Rainer, 2003).

Novelty as Stimuli Unexpected in a Given Context

Contextual novelty refers to an event or stimulus occurring out of context or out of place (Ranganath & Rainer, 2003). An example of this could be a naked guy walking into a lecture hall for a class (this is an example from Ranganath and Rainer (2003) from UC Berkeley). This type of novelty would also include an item being moved from its original location – a manipulation which is often used in eye-tracking research. Contextual novelty spurs an orienting response by which attentional resources are automatically diverted to the unexpected or out-of-place stimulus (Ranganath & Rainer, 2003).

Novelty as a Reconfiguration of Familiar Elements

Associative novelty, as it is referred to, is the type of novelty that is induced when individual aspects of a scenario are familiar, however, the arrangement or relationship of them within a situation is new (Kumaran & Maguire, 2007; O'Keefe & Nadel, 1978). For instance, O'Keefe and Nadel (1978) give the example: “the novelty of the wife in the best friend's bed lies neither in the wife, nor the friend, nor the bed, but in the unfamiliar conjunction of the three” (p. 241). The novel arrangement of familiar elements can present as a rearrangement in time (Honey et al., 1998; Kumaran & Maguire, 2007) or as a rearrangement in space (Kumaran & Maguire, 2007; O'Keefe & Nadel, 1978). Both of which, in animal work have shown to provoke an orienting response (Honey et al., 1998; Kumaran & Maguire, 2007; O'Keefe & Nadel, 1978).

Novelty as Known Stimuli Unfamiliar From Lack of Presentation on an Earlier Study List

An additional way to view novelty arises from memory research; particularly, as the inverse of familiarity when a task involves identifying items from a test list that had previously been presented on a study list (distinguishing old from new). Some stimuli are considered novel because their initial presentation is in a test phase and they were not present on a prior study list (although these stimuli may very well be known out of the experimental environment). This type of novelty is highly related to the others discussed above and may actually fit in to the associative novelty category; however, it is separated here due to its specific applicability in list-learning paradigms.

Special Treatment of Novel Stimuli

Novel stimuli never before seen from the environment are processed differently than stimuli one has already come in contact with. Evidence for this can be seen at a basic physical level as well as at broader, more cognitive levels. At a very basic, neuronal level, findings have revealed that neurons in the hippocampal and parahippocampal regions, regions important for memory, show an increase in firing patterns for novel stimuli as opposed to stimuli that have previously been encountered (Kumaran & Maguire, 2007; Viskontas, Knowlton, Steinmetz, &

Fried, 2006). These neurons decrease firing (or are acted upon by inhibitory neurons) as early as the second exposure to the stimulus (Viskontas, Knowlton, Steinmetz, & Fried, 2006). It is this difference in response even at this basic level to the repetition of stimuli that is integral in the explanation of stimulus novelty explained above (in 'Novelty as stimuli never before seen' section) (Ranganath & Rainer, 2003). The differential behavior of these neurons in response to novelty implicates the hippocampus and parahippocampal regions as taking on a role of novelty detector, comparing present experience to memory representations to detect if something is new (Gray, 2000; Kumaran & Maguire, 2007). This is consistent with animal studies that have looked into the brain regions involved in maintenance of familiar and novel stimuli and suggestions that prefrontal regions may be important for handling and matching familiar stimuli while medial temporal regions may be responsible for handling the novel stimuli (Stern, Sherman, Kirchoff, & Hasselmo, 2001).

In addition, research investigating neurochemical responses to novel stimuli during learning has shown that dopaminergic circuitry is involved in attendance to and processing of novel stimuli. Dopamine cells have been found to play a large role in motivation and reward and, accordingly, are implicated in learning. While dopamine cells have been observed to fire in response to stimuli where reward is expected, dopamine cells have also been observed to fire in response to novel stimuli. These novel stimuli may not be, and most often are not, predictive of reward (Bunzeck et al., 2009; Kakade & Dayan, 2002). A few theories for why the dopaminergic system would attend to novelty have been proposed. For one, novelty may be rewarding in itself. If we think back to an adaptive strategy, this makes sense; finding and exploring novel information allows us the opportunity to learn. An alternate idea is that this system is involved in novelty detection because its job is to evaluate situations for potential reward. If a situation is novel, its possible pairing with reward is still unknown, in which case it would be maintained in working memory until evaluation of this relationship can take place (Bunzeck, et al., 2009; Kakade & Dayan, 2002).

Overall, the dopaminergic system may be involved in orienting us to novel stimuli and, in turn, in motivating behavior in response to that stimulus. For instance, the dopamine system of a rat may be involved in detecting a novel environment and, upon this detection, the rat may then be oriented to that environment (via dopamine release in the striatum) and then engage in exploratory behavior (Bunzeck, et al., 2009; Kakade & Dayan, 2002). These responses are assumed to be automatic or mechanical. In the same manner that the dopaminergic system would respond to reward, dopamine is released in the striatum, which is then able to initiate a course of action as a response. Therefore, novel stimuli are able to capture our attention and influence the way we make decisions (Bunzeck, et al., 2009; Kakade & Dayan, 2002).

Further research into the neurotransmitter correlates of memory paradigms concerned with familiar and novel stimuli has found a difference in hippocampal glutamate efflux for the two types of stimuli as well (Ranganath & Rainer, 2003; Stanley, Wilson, & Fadel, 2012). In particular, glutamate efflux is heightened during exposure to novel stimuli whereas this is not above baseline during exposure to familiar stimuli. In this research, rats were presented with both familiar and novel objects in an exploratory environment while hippocampal acetylcholine (ACh), glutamate, and GABA efflux were measured through in vivo microdialysis. According to behavioral observations, the animals more often oriented toward the novel object in their exploratory behavior over the familiar object. In any case of exploration (familiar object or novel object), this exploration was paired with an increase in hippocampal ACh efflux, and no changes in GABA efflux. This research implicates glutamate as having particular involvement in novelty recognition (Stanley, Wilson, & Fadel, 2012). However, other studies have found indications that Ach as well can have a differential reaction to novel stimuli and have suggested that it may be instrumental in the encoding process via its involvement with NMDA receptors during long term potentiation and its role in elevating neuronal activity in response to stimuli in various regions of the brain (Ranganath & Rainer, 2003; Stanley, Wilson, & Fadel, 2012). All of these studies suggest different mechanisms involved in processing novel and familiar stimuli.

Associative novelty detection has also been more specifically linked to the hippocampus. Hippocampal neurons are said to be integral in forming a cognitive map, where associations between activity of these neurons concerned with space (place cells, head direction cells, grid cells, etc.) are integrated with proprioceptive and environmental cues (Buzsaki, 2006). To form a cognitive map, associations must be made between stimuli and context (O'Keefe & Nadel, 1978). Cues present in the environment that are contrary to an established association will result in association novelty and a novelty response. This can be observed in studies of rats in a Morris water maze. When the escape platform is moved to a new location after past trials of the platform in one location, the firing rate of hippocampal neurons increases (O'Keefe & Nadel, 1978).

Similarly, a study that explored these concepts of associative novelty in humans using fMRI discovered a novelty response demonstrated by increased activity in the parahippocampal region during an associative recognition memory task (Duzel et al., 2003). The researchers had participants engage in a task that involved them learning associations between pairs of stimuli presented on a screen. They were then tested on these learned associations in a recognition memory test either based on the spatial arrangement of the items presented or the identity of the items presented. Brain activity within parahippocampal regions was dissociated between these different types of recognition judgments. Specifically, parahippocampal cortices were more active for both types of recognition judgments when the stimuli were recognized as an old pair (versus a new pair of items). More activity was observed in the hippocampal formation, however, when novel pairs of stimuli were recognized. More activity was also observed in this area when the recognition judgment had to be made based on spatial arrangement (Duzel et al., 2003). These findings support a neural basis for novelty encoding and suggest that different types of novelty might have different neural substrates.

Novel Stimuli Capture Attention

One might be able to deduce from the neurological evidence that novel stimuli are processed differently cognitively as well. Indeed, behavioral paradigms have revealed that novel stimuli capture attention. One finding that has consistently been observed through eye-tracking experiments is that we tend to be drawn to novel stimuli and focus our gaze on these stimuli longer than familiar stimuli. This effect is seen across modalities or different types of stimuli. Althoff and Cohen (1999) reported it when they tracked the eye movements of subjects presented with famous and non-famous faces over the course of two sessions two weeks apart. They observed different patterns of eye movements dependent upon whether the face was famous (familiar) or non-famous (never before seen). Specifically, eye movements for non-famous faces had a more predictable and stable pattern than those for famous faces. This occurred regardless of the task that the participant was asked to carry out (whether it was to attend to 'famousness' of these faces or to the emotion expressed in these faces) (Althoff & Cohen, 1999).

An earlier study showed the same effect with faces and buildings. These researchers referred to this effect as the “eye-movement-based memory effect” (Althoff & Cohen, 1999; Cohen et al., 1998). This effect is likely the result of an unconscious process since manipulation of the judgments to be made did not change whether there was this difference in pattern of eye movements and fixations between faces the participants had previously been exposed to (famous) and those which were new or novel (non-famous). This effect occurred independently of recognition decisions. The eye-tracking results seem to result from a top-down process by which prior experience with stimuli shape the way information is processed (Althoff & Cohen, 1999).

In an additional study investigating the eye-movement memory effect and unconscious processing of novel stimuli, Ryan, Althoff, Whitlow, and Cohen (2000) presented subjects with pictures of scenes. These scenes were presented in three different manners over the course of the experiment: once within the three blocks (novel scenes), once in each block of the experiment (repeated scenes), or once in each of the first two blocks in an original form and then presented again in the third block in an altered form, wherein an object was added to the photo, taken out, or shifted (these were referred to as 'manipulated scenes' in the original paper). Subjects' eye movements were measured and compared across these conditions. The researchers were particularly interested in observing the number of fixations and the number of regions of the photograph sampled when photographs had been manipulated as opposed to those when photographs belonged to the repeated or novel conditions. Consistent with their earlier work (showing more eye movement and fixations to items semantically incongruent with their embedded scene), they observed a repetition effect by which fewer regions of the photograph were sampled and fewer fixations occurred when the photograph was repeated or manipulated as opposed to when the photograph was novel. Just as they had found with their face research, stimuli that were novel (both never before seen and contextual) received more sampling and more fixations from viewers (Ryan et al., 2000).

Enhanced Memory for Novel Stimuli

Behavioral studies also suggest that novel stimuli are better remembered. Similar to the Von Restorff effect (also referred to as the isolation effect), which shows better memory for items that are unusual or stand out in some way (Hunt, 1995; Von Restorff, 1933), a general consensus is that, not only do we attend to novel stimuli at a higher degree, but that we also tend to have better memory for these novel stimuli when tested on them later (Lubow & Moore, 1959; Wang & Mitchell, 2011). Various theories have set out to explain why this is. Two of these theories that predominate the literature are: the attention-likelihood theory and the novelty/encoding hypothesis, both of which incorporate attention and memory (Diana & Reder, 2006; Kim, Yi, Raye, & Johnson, 2012; Tulving & Kroll, 1995).

The attention-likelihood theory holds that novel items, or those that occur infrequently, and the features related to them receive more attention in the encoding process and therefore have stronger tags in the memory trace that later provide an ease at retrieval. Basically, because of the attentional focus on novel items, they are consolidated more strongly (Diana & Reder, 2006; Kim et al., 2012). Support for this theory exists in research that shows that source judgments for low frequency (novel) items are more accurate than those for high-frequency (familiar) items. This aligns with the idea that the features associated with novel stimuli, including context or source information will be more likely to be remembered than those associated with familiar items. This can also provide support for recognition research that shows that items presented more frequently coincide with a lower hit rate and a higher false alarm rate than novel items (Diana & Reder, 2006; Kim et al., 2012).

These research findings can also be examined through the similar perspective of a novelty/encoding explanation as put forth by Tulving and Kroll (1995). The idea behind this theory is that neural networks assess incoming information for 'worthiness' for long-term storage whereby encoding depends upon the novelty of the information. This, again, can account for the finding that better memory is observed for novel items (and the context that enshrouds them) than items that have been repeated (Kim et al., 2012; Tulving & Kroll, 1995). Because the hippocampus is a key player in memory encoding processes, this explanation also pairs nicely with the idea of novelty detection within our hippocampal circuitry (Gray, 2000; Viskontas et al., 2006).

Diana and Reder (2006) investigated how the degree of novelty of an item could influence familiarity-based judgments and source/contextual information at both encoding and retrieval through the use of low and high frequency words (frequency determined by frequency of use within the language; ex: low frequency word – tribunal or aberrant, high frequency word – increased or earlier). They hypothesized that because novel information captures attention and requires deeper processing at encoding, recognition for information paired with the low frequency words at a study phase would be impaired when later tested on that information alone compared to that of information that was paired with the high frequency words in the initial phase. However, at the time of retrieval they suspected that among those that have been successfully encoded, low frequency words would be associated with more accurate source judgments or recollection of contextual details (they provided this by varying the background color of the slides the words were presented on). The idea here is that the low frequency words are more novel, and therefore, initially require more attention but are better encoded, whereas the high frequency words require fewer attentional resources at encoding but are not encoded as deeply. Their findings supported their predictions, suggesting increased processing of novel stimuli at encoding and a retrieval advantage for these stimuli and contextual details associated with them at test (Diana & Reder, 2006).

In a study that sought to explore this idea further and tease apart the degree of familiarity or novelty and the methods by which the stimuli are presented in order to examine ability to discriminate between stimuli, Mundy, Honey and Dwyer (2007) presented subjects with four pairs of yearbook-type photographs of faces and asked them to make categorization decisions. These photographs were morphed in order to present subjects with very similar portrait photographs as a pair at different levels of discriminability and the presentation of these photographs was manipulated among these exposures. Types of presentations included, alternations of the photographs, interspersed among the other presented photos, and blocks, in which one photo was presented repeatedly, followed by the other. They found that preexposure overall facilitated the ability to discriminate between faces in the photographs. They also found that the alternated presentation of the photographs was beneficial to ability to discriminate between them (Mundy, Honey, & Dwyer, 2007). It is thought that alternating presentation between stimuli enhances attention to the unique or novel aspects of the photos, allowing better discriminability. Again, similar findings have been observed when stimuli are more abstract, such as screens of colored squares (Wang & Mitchell, 2011). These findings, similar to those of Ryan and colleagues (2000) and building upon work in attention, provide support again for a system designed to detect novelty or differences between incoming perceptual information and to remember them better. We are rapidly comparing incoming stream of stimuli in our environment to representations in our memory in order to discern old from new. From this derivative, we are able to determine how to respond to those stimuli.

Novelty in Recognition Memory Paradigms

Dual-process theories of recognition memory outline two distinct processes that are at play in recognition: recollection and familiarity. Recollection is defined as remembering or calling to mind the details of an event or stimulus, and familiarity is defined as the feeling that one has experienced something before (Cleary, 2004; Mandler, 2008; Yonelinas, 2002). Various dual process theories have been postulated since that original distinction was made.

Most dual process theories agree that familiarity is an initial subjective experience upon encountering some type of stimuli in which one feels as if he has experienced that stimulus before. It is generally thought to be a fast, almost automatic response, with no requirements of further retrieval or generation of contextual details. Recollection, on the other hand, does require this extended search (Mandler, 2008). This being said, these two concepts or dimensions of recognition are thought to occur in a time sequence, whereby when encountering an event or stimulus, first a familiarity process based on perceptual input is instigated and then, if immediate recognition does not take place based on the intensity of the familiarity response, additional information about the target stimuli is sought out to provide details and identification of that target (Mandler, 2008). The second process would be the slower process of recollection. For instance, where subjects have been tasked with making decisions about items that had been previously studied and those that had not under time constraints, they were accurately able to make these distinctions (based on familiarity) faster than they could recollect details about the target stimuli or the context under which they were presented in (Hintzman & Curran, 1994; Yonelinas, 2002). Although there is a difference in pace of these processes, they are thought to be parallel processes, occurring in tandem (Mandler, 2008). In short, familiarity is the initial experience of knowing one has experienced some event before and recollection is actively retrieving contextual details about that event or object (Mandler, 2008).

Many researchers who operate within the dual process framework have examined issues of subjective experience in recognition through their assessment of the familiarity response. The distinction between familiarity and recollection often entails a description of degree of access the individual has to aspects of his or her own memory. For example, in the remember-know paradigm, subjects are presented with test items, some of which appeared on an earlier study list. For each test item, subjects are asked to make an old-new recognition judgment followed by a self-assessment of the basis of that judgment. “Remember” responses mean the basis of that judgment was recollection; “Know” responses mean the basis was a mere feeling of familiarity (Cleary, 2004; Mandler, 2008; Tulving & Kroll, 1995; Yonelinas, 2002).

Other evidence supporting dual-process theory comes from research using what is called the recognition without cued recall (RWCR) paradigm (Cleary, 2004; Ryals & Cleary, 2012). In the RWCR paradigm subjects are presented with study words (ex: distraction) and are then presented with non-word test cues. Half of the non-word test cues are graphemically similar to study list items (ex: disfraption) and half are non-words with no resemblance to study items (ex: twilfight). At test, subjects are asked to rate the familiarity of the test cue or the likelihood that a similar word to the test cue appeared on the study list on a 0 to 10 scale (0=not familiar or no likelihood of previous presentation, and 10=very familiar or high likelihood of previous presentation). Subjects are also asked to identify the corresponding word from the study list (that resembles the test cue) if they are able to do so. Ryals and Cleary (2012) examined the RWCR effect and results of their study support the idea that overlap in specific features between the test item and the studied items can activate a familiarity response and that the strength of this familiarity response can be mediated by the degree of feature match; non-word test cues that more closely resembled study words were associated with higher familiarity ratings than non-words with low resemblance (Ryals & Cleary, 2012).

Additionally, the study showed that recognition in the presence of cued recall and recognition without cued recall behave in very different ways. Factors that affect the presence and strength of familiarity ratings with cued recall success, such as the concreteness (vs. abstractness) of the word's semantic meaning, did not exhibit an effect on familiarity ratings in instances of cued recall failure. In the presence of recall, familiarity ratings are higher for concrete words than they are for abstract words, but when recall fails, the concreteness of the word makes relatively no difference on the familiarity ratings for those words (Ryals & Cleary, 2012). This supports the dual process perspective and suggests that different mechanisms may be at play in making the two different types of responses. While the recognition response in the presence of recall seems to be facilitated by (amount of) information that can be generated about the test cue, the recognition response when recall fails may be driven by (amount of) similarity of individual graphemic or orthographic features (Ryals & Cleary, 2012).

As discussed throughout this section, much research that has supported dual process theories in suggesting that there may be more than one process occurring in the workings of recognition memory. Others have examined how the subjective experiences of familiarity differ from recollection (e.g., remember-know studies). A question then arises as to whether there are only two processes involved in recognition. In these list-learning paradigms, novelty is typically thought of as the polar opposite or inverse of familiarity on a spectrum and this relationship is represented in the literature as somewhat dichotomous; an item is either familiar or it is novel. This approach to novelty revisits the definition laid out earlier as 'novelty as known stimuli unfamiliar due to lack of presentation on an earlier study list.' This concept of novelty permeates within the typical remember/know recognition paradigm; one must be able to distinguish between old and new in order to learn information and one must also be able to tell what is 'old' in order to make a 'new' judgment. Could novelty be another process at play in the mechanisms of recognition memory? How does this translate in terms of novel experiences?

Subjective Experiences of Memory

Interest in subjective experiences of memory and in how these experiences map onto results of objective measures has begun to emerge within the research literature. Among some of the subjective phenomena that are described in the literature are feelings of familiarity (described in the previous section) (e.g., Mandler, 2008; Yonelinas, 2002), feelings of knowing (e.g., Koriat & Leiblich, 1977), tip-of-the-tongue-experiences (e.g., see Schwartz, 2002, for a review), and déjà vu experiences (e.g., Brown & Marsh, 2010; Cleary, 2008; Cleary, Ryals & Nomi, 2009; Cleary et al., 2012).

Feelings of knowing, or feelings about one's future ability to recognize an inaccessible target item if tested on it later, have been shown to be able to be influenced by manipulations of fluency of the cue although outcomes of objective recognition measures remain unchanged (Koriat, 2000; Koriat & Leiblich, 1977). The tip-of-the-tongue phenomenon, or the feeling that recall is imminent and that the memory for an item is on the verge of being accessed (although not accessible at that moment), has been explained as a metacognitive phenomenon possibly resulting from increased accessibility of information associated to the target leading to a inflated feeling of accessibility of the target itself (Schwartz, 1999; 2002).

Deja vu has been defined as the experience of having experienced something before while having a concurrent awareness that the situation is new. Researchers attribute this subjective feeling to a high feeling of familiarity for an event paired with a failure to retrieve any contextual details of that event and evidence that the event could not have been experienced before (Brown, 2004; Cleary, 2008; Cleary, Ryals, & Nomi, 2009). To investigate possible mechanisms at play in the experience of deja vu, Cleary and colleagues (2012) used virtual reality to manipulate scene presentations. At study, subjects were allowed to explore various rooms, each accompanied by a room title. At test, three types of scenes were then presented: the exact rooms that had been presented in the study phase, rooms that were novel but configurally similar to those presented in the study phase (for example, a room titled 'bowling alley' that would map on to a room that looked like a subway station in its configuration of elements in the room), and rooms that were novel and shared no configural details to study rooms. Subjects were asked to rate the familiarity of these test rooms and to also identify, if they could, a room from the study phase that was similar to the test room currently being presented. A recognition without cued recall effect was observed; subjects rated the rooms that were configurally similar to those they had been presented with during the study phase as more familiar even when they were unable to explicitly identify a room from the study phase that the current room resembled (Cleary et al., 2012).

Within the theory of familiarity, the more similar a cue is to the original presentation of the stimulus, the higher the familiarity signal and the more likely one is to feel deja vu or a high subjective feeling of familiarity (Cleary et al., 2012). Along these lines, the greater degree of configural similarity, the higher the familiarity ratings should be and the higher the likelihood of reporting deja vu. Speaking to this, the results of this experiment showed that when participants were exposed a second time to the exact room that they had seen in the study phase, yet failed to identify the room as 'old', the familiarity ratings and deja vu proportions were even higher than they were for configurally similar rooms (Cleary et al., 2012). This impels a question: why did the subjects fail to recollect that they had actually been in that room before? It seems that the subjects are experiencing high familiarity for these rooms, due to their reported familiarity ratings, in tandem with a high sense that the room is new, as evidenced by their reporting the room as new in their recognition judgments. Can deja vu then be characterized by a high feeling of familiarity occurring simultaneously with a high feeling of novelty? If this is the case, the classic way of looking at novelty as on the opposite end of a familiarity spectrum may need to be rethought. If feelings of familiarity and feelings of novelty can occur in unison, perhaps familiarity and novelty are, rather, two separate dimensions.

According to the studies discussed above and other research on the topic, one could suppose that familiarity and recollection could exist on separate continuums and various levels of each could be experienced. However, with regard to novelty, is novelty just low on the continuum of each of these forms of recognition or is novelty on a continuum of its own?

The Subjective Experience of Novelty

The present study is concerned with how novelty is experienced at a subjective level. Perhaps the best example of a subjective experience of novelty is what is known as the "jamais vu" experience. Jamais vu may be thought of as the opposite of deja vu, described as a jarring feeling of novelty in a situation that one knows should be familiar (Brown, 2004; Brown & Marsh, 2010; Cleary, 2008; Read, Vokey, & Davidson, 1991). That is, while deja vu is the subjective feeling of familiarity during expected novelty, jamais vu is the subjective feeling of novelty under circumstances of expected familiarity (Brown, 2004; Brown & Marsh, 2010; Cleary, 2008; Read, Vokey, & Davidson, 1991). This simultaneous feeling of unfamiliarity and familiarity is a relatively rare experience compared to that of some of the other phenomena discussed, yet it has been recorded with more frequency in a subset of individuals with temporal lobe epilepsy just before the onset of an epileptic seizure (Lardreau, 2011; O'Connor et al., 2010; O'Connor & Moulin, 2010). The mechanisms behind this phenomenon are unknown, however, some have suspected that the same factors involved in creating some of the other subjective memory experiences are the root cause here as well (Brown, 2004; Brown & Marsh, 2010; Cleary, 2008; Read, Vokey, & Davidson, 1991).

The Capgras delusion may be another example of a subjective experience of novelty. This is a delusion that has been observed among people with organic brain disorders in which a person will be able to recognize people close to them (such as friends or family members or even pets) as looking like those people (and having the same mannerisms, etc.), but will be convinced that these people are impostors. Interestingly, the delusion does not arise if the person is presented with only auditory information, such as when talking to their loved one on the phone (Brown, 2004; Ellis, Young, Quayle, & de Pauw, 1997). Some theories as to the etiology of this disorder have proposed that the limbic centers that bind emotion to memories (or emotion evaluation areas; amygdala) have been detached in some way from the visual representations of the memories (or visual recognition areas; fusiform gyrus) in these cases (Ellis, Young, Quayle, & de Pauw, 1997; Ramachandran, 2004). This explanation has been supported by research that has shown no difference in autonomic response to familiar versus unfamiliar faces among those diagnosed with Capgras, whereas a more pronounced autonomic orienting response is observed for familiar faces than for unfamiliar faces within a group of healthy controls and when auditory stimuli is used (familiar vs unfamiliar voices) among those diagnosed with the disorder (Ellis, Young, Quayle, & de Pauw, 1997; Ramachandran, 2004).

A more common experience of novelty may be found in relationship to reading language. A Google search of "staring at a word too long" turns out numerous results (Google responds "about 50,400,000"). Many of these describe the sensation of having a word lose its meaning or feel foreign, or even of the word no longer seeming like a word after it is repeated somehow (usually read over and over or written over and over). They also usually include inquiries as to what this experience is called and whether others are experiencing it as well. Here are a couple examples from the first few search results:

> (Perhaps this only happens to me, but I doubt it.)
> Sometimes after looking at a word for a while, I become convinced that it can't possibly be spelled correctly. Even after looking it up, sounding it out, and realizing that there's simply no other way to spell the word, it still looks wrong. Is there a shorthand way to describe this feeling so that people will know what I mean without the long explanation?
> (http://english.stackexchange.com/questions/6170/is-there-a-word-or-phrase-for-the-feeling-you-get-after-looking-at-a-word-for-to)
>
> If you say a certain word enough times, it starts to sound/feel different. I had this today with the word patio, and in the end I felt like I barely know the word anymore.
> I am not sure how else to describe this, but that's pretty much the reason I'm asking – what is this phenomenon called
> (http://english.stackexchange.com/questions/46306/ whats-the-term-for-when-a-word-is-said-so-many-times-it-sounds-weird)

Can these case study and anecdotal reports of experiences described above be attributed to merely a very low subjective feeling of familiarity or is the feeling of a 'novel' experience important and separate? Is it possible to simultaneously have both the subjective feeling of familiarity and the subjective feeling of novelty as in deja vu? While these examples of subjective experiences of novelty exist anecdotally, few studies have actually DIRECTLY examined the subjective experience of novelty. However, some literatures may be particularly relevant to the question of how novelty is subjectively experienced.

Potential Mechanisms of the Subjective Experience of Novelty

Semantic Satiation as a Potential Mechanism of Subjective Experiences of Novelty

The experience of novelty alongside the experience of familiarity has been likened to descriptions of “word blindness” and semantic satiation (See Brown, 2004, p. 109). Semantic satiation is one term that has been used to describe the habituation that can occur from repeated exposure to the same stimuli. Neely (1977a; 1977b) used a standard semantic priming procedure to examine satiation. What is observed in this standard paradigm is that the speed of lexical decisions (deciding whether the word presented was a word or a non-word) is modulated by the semantic relatedness of words presented during priming; when a prime word has semantic association to the target, the decision is made faster. Priming is therefore effective not just for visual features of words, but for semantic associations as well. The presentation of a prime word activates memory representations of that word along with sources and associations related to that word, which, in turn, leads to a faster response when the prime is semantically related to the target word. Whereas some activation of the representation from priming should lead to increased accessibility, Neely was interested in whether there could be too much activation, leading to over-saturation of the representation and decreased accessibility of the target.

Neely (1977a; 1977b) posited that extended repetition of the prime should result in semantic satiation, similar to a habituation response for the prime. That is, he expected to reverse the effects seen in the lexical decision task so that words presented with prolonged repetition of a prime would actually result in a longer time to make a decision than words which had been primed with fewer repetitions. His observations of this task when manipulating duration of repetitions of the prime word did not match his expectations in this lexical task (Neely 1977a, 1977b). However, this predicted reversal of priming effects was observed in an alternate experiment carried out by Smith and Klein (1990) when subjects were tasked with making a semantic decision. This consisted of subjects being presented with a category title that they either had to say aloud three times or thirty times. They were then presented with a target word and asked to make a decision about whether the target word was a member of the category that they had just been repeating. Decision times were significantly longer when the target word was actually a member of that category than when the target word did not belong to the category that had been repeated. Decision times were also slower for the category titles that the participants repeated thirty times versus those they repeated three times. This suggests that extended repetition of a prime can decrease access to semantic information related to that prime, consistent with the semantic satiation hypothesis (Smith & Klein, 1990).

Smith and Klein (1990) refer to semantic satiation as "the *subjective experience* of loss of meaning of a word as a result of prolonged inspection and repetition of that word" (p. 852) and note what it is like to experience this effect first hand. They describe accounts of feelings that the stimuli have lost meaning and familiarity as well as the inability to recognize the stimulus for what it is from physical or phonetic features. For instance, if the stimulus is a word, the word no longer looks like or sounds like a word (although, according to Neely's research, the knowledge that the stimulus is actually a word does not diminish) (Smith & Klein, 1990).

A further study that attempted to explore semantic satiation as a potential mechanism involved in jamais vu was carried out by Chris Moulin's group at the University of Leeds and was described in a presentation at the Fourth International Conference on Memory held in Sydney, Australia in 2006 (as described in ABC Science Online; Skatssoon, 2006). Ninety-two subjects were asked to write out frequently used words, such as "door," 30 times each for 60 seconds and were then asked to describe their experiences of this task. Sixty-eight percent of these subjects wrote descriptions that were categorized as mirroring the jamais vu phenomenon. For example, some subjects gave accounts like, “it looked like I was spelling something else”, it “sounded like a made-up word” or “I began to doubt that I was writing the correct word for the meaning” after repeatedly writing these words (Skatssoon, 2006). These responses to this task are similar to what people describe experiencing after staring to a word too long with both lexical and semantic associations more difficult to access after repeated exposure to the word and hints at how the subjective experience of novelty may be manipulated.

Semantic Satiation and the Jacoby-Whitehouse Effect

In research that investigated conscious awareness of priming and the effect of priming on recognition and familiarity, Jacoby and Whitehouse (1989) found that priming, or providing a matching 'context' word, below the level of conscious awareness (flashed for only 50ms) just prior to a test word led to an increased level of false recognition for the test word (claiming that this word had been on an initial phase study list). Test words were medium-frequency five-letter nouns and the conditions of context words in this task were context words that matched the test word that would follow, context words that did not match the test word, and no context words. As in other priming and recognition memory paradigms, for the test list Jacoby and Whitehouse also used both old words, or words that had appeared on an earlier study list, and new words, or words that had not been presented earlier within the experiment. Their findings that the matching prime increased false alarms in recognition judgments is explained by the authors as being due to an increased familiarity signal as a direct effect of the flashing of the context word which is misattributed to the likelihood that the word had been presented on the study list. Interestingly, this effect is reversed when the subjects were made aware of the context words, or when the presence of these words was brought to conscious attention through a longer prime duration (e.g., 200ms); less false recognition takes place in this circumstance. This also adheres to the authors' theory in that, once subjects are made aware that these context words are flashing prior to the presentation of the test words, they are no longer prone to falsely attribute the increased feeling of familiarity to the word having been presented on the study list. Instead, they realize that the feeling of familiarity may arise due to the presentation of the context word at test. Jacoby and Whitehouse (1989) hold that these effects are due to the differences in familiarity and recollection and the degree of reliance on the familiarity signal rather than priming and an increase in perceptual fluency.

More recent work by Huber and colleagues (2008) suggests that the Jacoby-Whitehouse paradigm can be used to induce something similar to semantic satiation, and that this in turn, may relate to experiences of novelty (defined as unfamiliarity). In the model suggested by this group, the perceptual fluency-disfluency model, priming and perceptual fluency have a bell-shaped relationship such that short duration of priming will increase perceptual fluency (as is suggested in the Jacoby-Whitehouse effect) to an extent, from which point, longer durations of priming will create disfluency. Perceptual fluency is the idea that previous experience or knowledge of a stimulus increases ease and, consequently, speed of processing. The model includes a structure that includes a perceptual level, an orthographic level, a lexical/semantic level, and a familiarity level, each previous level feeding into the next and can affect processing of the stimuli (See Figure 1). According to Huber et al.'s model, both perceptual fluency and familiarity for primed targets are amplified through short prime durations, whereas habituation is facilitated through long prime durations, resulting in perceptual disfluency and depressed familiarity. They also propose variability in the degree of priming it would take to result in disfluency. Negative priming or disfluency is acquired more rapidly for more familiar items; they activate more quickly and, in turn, habituate more quickly. Therefore, difference in length of prime duration required to reach a point of disfluency differs according to initial familiarity of the material (Huber, 2008; Huber, Clark, Curran, & Winkielman, 2008).

Huber and colleagues (2008) observed support for these fluency effects through a series of experiments in which prime duration was manipulated and tests of recognition were employed. Experiment three as outlined in their paper is particularly relevant to the issues discussed here. In this experiment, subjects studied lists of (36) random 5-letter word pairs. Each study list was followed by a forced-choice recognition test which included (24) pairs of target and foil words (the targets were words that had been presented in the study list and the foils were words that had not been presented in the study list) and a prime was flashed before each test pair. The subject was instructed to identify which of the words had been presented at study. There were three prime types: neither target nor foil word primed, target word primed, or foil word primed, and two prime durations: 100ms for a short prime or 1000ms for a long prime. Following the recognition response, participants were provided with feedback about which of the words was the correct (target) word that had been presented in the study phase and were then asked to identify the word that it was paired with at study if they were able to do so. This methodology was brought on by the prediction that recollection should not be affected by the manipulation of perceptual fluency or pre-activation (since recollecting involves generation of missing information as opposed to strength of the response) but that recognition judgments of past experiments may have been diluted by reliance on recollection when making remember/know or old/new responses. In this way, the experimenters were able to look at recognition with and without cued recall to isolate familiarity within the recognition judgment (Huber, Clark, Curran, & Winkielman, 2008).

In general, Huber and colleagues (2008) found that recognition was enhanced through short duration primes whereas long duration primes seemed to have the opposite effect, with primed words lessening likelihood of recognition for the related target. This effect was observed even when subjects were explicitly asked about the duration of primes and were able to identify the shorter primes and it persisted, manifesting when familiarity-based recognition decisions were made apparent by cued-recall failure. The results of their manipulations suggest that priming can have a unique effect on familiarity while leaving recollection virtually unaffected (Huber, Clark, Curran, & Winkielman, 2008).

Inhibition/Interference as an Alternative Mechanism Underlying Subjective Novelty Experiences

Despite the promising findings emerging in the semantic satiation and priming literature, other mechanisms may underlie novelty experiences. One such possibility can be seen in data collected by Neely (1976; 1977b) in an experiment aimed to uncover mechanisms of semantic facilitation in lexical decision tasks or faster reaction times when primes are related to the target word. In this experiment, reaction times were recorded during a lexical decision task for which the subject would have to decide whether the target item presented on screen was a word or a nonword. Each of these items were primed prior to presentation in one of three prime conditions: the prime was a related word, the prime was an unrelated word, or the prime was a neutral nonword (such as, XXX). Three prime durations (or SOAs) were used as well: 360ms, 600ms, 2000ms.

What Neely termed as 'inhibition' referred to anything that might show an inflated reaction time for the target word (or nonword) as compared to the reaction time when the neutral prime was exhibited (used as the baseline). In contrast, 'facilitation' is used to refer to when a factor is able to decrease reaction time for the task. An 'inhibition effect' was observed for target words accompanied by longer prime durations when the prime was an unrelated word; unrelated word primes at longer durations led to increased reaction times for the lexical decision task of the target word than did related primes or neutral primes at the long duration and reaction time decreased as prime duration got shorter (Neely, 1976). Neely proposed, in lines with other research at the time, that these results may be reflective of an attentional strategy used by the participants in that they are misdirecting their attention to the primes and the shift in limited attention when the target word is not related to the prime creates a disadvantage for processing of the target word. In this way, the prime may be causing an interference when the prime and the target are dissimilar by activating associations related to the prime and making it harder or slower to activate associations related to the target word when it appears (Neely, 1976; 1977b). Unlike the implications of the fluency-disfluency model and the satiation effect, this alternative inhibition/interference approach would predict depressed abilities in processing of a target following prolonged exposure to an unrelated prime. This depressed ability may create a reduction in familiarity for a target, and in turn, enhance subjective novelty.

EXPERIMENT 1: A PILOT INVESTIGATION

A pilot study was carried out in order to test a hybrid of the Huber (2008) fluency-disfluency paradigm (a variant of the Jacoby-Whitehouse paradigm), using the recognition without cued recall paradigm of Cleary and colleagues (Cleary, 2004; Ryals & Cleary, 2012) and to further prod the characteristics that may be involved in creating 'unfamiliarity'. The recognition without cued recall paradigm was used, as it was by Ryals and Cleary (2012), as it allows an isolation of familiarity through investigation of recognition in the absence of recall. More specifically, by removing instances in which recall succeeded, the method allows an examination of judgments that are based on other processes than recollection, such as familiarity, or in the case of the present proposal, novelty.

As in Ryals and Cleary (2012), this pilot study utilized study words (ex: distraction, tribute, elbow) and nonword test cues, of which, half resembled studied items in terms of graphemic features (ex: disfraption for the study word distraction) and half did not (ex: dovil). The pilot employed the methods and materials of Experiment 1 (Ryals & Cleary, 2012), with additional examination of different durations of exposure to primes. More specifically, prior to the test cues we incorporated Huber et al.'s variant of the Jacoby-Whitehouse paradigm. In the hybrid paradigm used for the pilot, nonword primes were used in addition to nonword test cues and subjects made recognition judgments about whether a *similar* word appeared on the study list.

Hypotheses

While this pilot was largely exploratory, to determine if unfamiliarity could be manipulated within the RWCR paradigm by manipulating a prime duration, some hypotheses as to expected outcomes were formulated given the prior literature. Overall, an RWCR effect was expected whereby test cues resembling study items that failed to be recalled would have higher familiarity ratings than test cues not resembling study items. In addition, consistent with the lines of Huber et al. (2008), test cues paired with long duration (1000ms), matching primes were expected to be met with lower familiarity ratings than those with the short duration (50ms), matching primes, those with long duration, mismatched primes, and those with short duration, mismatched primes (among test cues that do not lead to successful recall of the corresponding study item). Test cues paired with short duration (50ms), matching primes were expected to be met with higher familiarity ratings than those paired with all other prime conditions among test cues that would not lead to successful recall of the corresponding study item. When the prime does not match the test cue, prime duration should have no effect on the familiarity ratings and the RWCR effect should persist.

Method

Participants

Seventy Colorado State University undergraduate students were recruited from the CSU Psychology Department subject pool in the fall semester of 2012 and they were given course credit as a part of their introductory Psychology course requirements for participation in this study. Informed consent was obtained from each participant.

Materials

This program consisted of 6 blocks of study-test pairs. All stimuli were presented visually on the screen. The stimuli consisted of 192 potential study words and the corresponding graphemically similar test cues (e.g., disfraption for the study word distraction, and foneheed for the study word forehead) that had been used in the Ryals and Cleary (2012) experiment that investigated RWCR. Consistent with the paradigm used in that study, each study-test block consisted of 16 study words followed by 32 test cues, wherein half (16) of the test cues resembled study items and half (16) did not. Block order was randomized as was the order of presentation of study and test stimuli within each block.

All instructions for the task were presented via the E-Prime program and the participants were able to self-progress through the study by using the keyboard. Each study word was presented in the upper left corner of the computer screen in lower-case letters for 2 s with a 1 s inter-stimulus interval. Each study list was immediately followed by the corresponding test list. Each item in the test list included a prime that flashed prior to the presentation of the non-word test cue. These primes varied in whether they matched the non-word test cue that immediately followed (e.g., for the test cue of foneheed, the prime is foneheed) or whether the prime was a mismatching nonword that did not resemble a word from the study list (e.g., for the test cue foneheed, the prime is crawfed). The primes also varied in duration. Half of the trials had a 50ms prime and the remaining half of the trials had a 1000ms prime (16; 8 with matching primes). Thus, there were four types of prime type, prime duration trials: a) matching, 50ms primes (8 items), b) matching, 1000ms primes (8 items), c) mismatched, 50ms primes (8 items), d) mismatched, 1000ms primes (8 items). Prime durations were chosen based on the research by Huber and colleagues (2008) suggesting that 50ms prime durations enhanced recognition ratings while 1000ms prime durations provided enough overexposure to reverse the effect. Fifty millisecond primes flashed only once before the test cue. One thousand millisecond primes flashed in 20-50ms intervals with 50ms between each flash before the test cue. A pre- and post-prime mask was used ($$$$$$$$$$$) and was presented 500ms before and after the presentation of each prime (as per Huber et al., 2008). The test cue appeared immediately after presentation of the mask. Prime duration and matching context of the primes were counterbalanced among item assignment.

Procedure

All stimuli were presented via individual Dell computers in individual rooms. They were presented on E-Prime 2.0. Once participants had read through and signed the consent forms, and were led to the individual experiment booth, the program was started for them and they were able to self-progress through the experiment. Participants were instructed that they would be viewing words in a study list and that their memory for those words would later be tested in a following test list consisting of non-words. They were told that, at test, they would be asked to rate the likelihood that a similar word appeared in the study list and to give a rating of likelihood on a scale of 0-10, a rating of 0 indicating that they are sure a similar word did not appear in the study list and a rating of 10 meaning that they are sure a similar word did appear in the study list. They were asked to use the whole scale of ratings. They are also asked to try to identify a word that they studied that resembled the non-word and to type this word in when prompted if they are able to do so. The six study-test sessions would then begin.

For each study block, study items were presented one at a time for 2s with a 1s inter-stimulus interval. Each test list was preceded by the directions, “You will now begin the test phase. You will be viewing a list of non-words preceded by words or non-words that will be flashed briefly. You will need to judge the likelihood that the final word is similar to a word that appeared on the previous study list. You will also be asked to identify the word on the study list that this non-word resembles if you are able to do so. Press 1 to begin.” Each mask, prime, and test cue appeared in lower-case letters in the upper left corner of the screen. Congruous with the Ryals and Cleary (2012) study paradigm, for each cue presented on the test, participants were first asked to provide a familiarity rating for that cue using a 0 (very unfamiliar) to 10 (very familiar) scale to indicate the likelihood that the cue resembled a word from the previously studied list ("Please rate the likelihood that a similar word appeared in the study list on a 0-10 scale; 0=Completely Unsure, 10=Completely Sure). They were then asked if they could recall a word from the study list that resembled the test item and were prompted to type it into a dialogue box if they were able to do so (‘‘Do you recall a word from the study list that resembles this item? If so, type it in.’’). These measures allowed simultaneous examination of familiarity (ratings) and recollection (target identification proportions and familiarity ratings given in the presence of recall) across study status (test item associated with studied word vs unstudied), prime status (prime matching test cue vs mismatch), and prime duration (50ms prime vs 1000ms prime).

Results

Data Analyses

Data were hand coded for correct identification of target word. This was to ensure that spelling mistakes did not result in erroneously marking an identified item as unidentified.

Successful Recall Proportions

A repeated measures 2 (Study Status: target studied vs target not studied) x 2 (Prime Duration: 50ms prime vs 1000ms prime) x 2 (Prime Match Status: matching prime vs mismatched prime) analysis of variance (ANOVA) was conducted to analyze the proportion of targets recalled in response to the cues (correctly identified targets/total number of items) among the conditions (See Figure 3 for distribution). Other than a main effect of Study Status, no effects were predicted since the work of Huber and colleagues (2008) indicated that the prime duration manipulations should have virtually no effect on recollection performance. However, some research has suggested that part of what is observed in the Jacoby-Whitehouse effect may be due to a contribution of recollection. This is primarily spearheaded by studies that have shown that the standard remember-know procedure itself may be responsible for the lack of observed effects of priming on recollection and that recollection too may have an inferential component (See Kurilla & Westerman, 2008). Kurilla and Westerman (2008) were able to replicate the Jacoby-Whitehouse effect when they used this procedure, showing an isolated effect of prime duration (subliminal vs supraliminal primes) on familiarity (and no effect on recollection). However, when they instead applied an independent ratings response method (e.g., the subject was asked to provide a 1-4 rating of familiarity and a separate 1-4 rating of recollection for each test item), increasing both perceptual and conceptual fluency through the use of a brief prime led to both heightened familiarity ratings and recollection ratings.

In the present analysis, both the main effect of Study Status [higher proportions of correct target identifications were observed when test cues resembled studied items (M=.676) than when test cues did not resemble items from the study list (M=.21), $F(1,69)=523.96$, $p<.001$, $\eta^2=.884$] and the main effect of Prime Duration were significant [test cues following 50ms primes gave rise to significantly higher proportions of identifications than did test cues following 1000ms primes, $F(1,69)=5.83$, $p=.018$, $\eta^2=.078$]. The latter of these results suggests that, at least in this particular case, manipulating the duration of the prime did have an effect on recollection (See Table 1 and Figure 2). Since this occurred regardless of whether the prime matched the test cue, it could be an attentional effect. A significant study Status x Prime Match Status interaction occurred, $F(1,69)=4.603$, $p=.035$, $\eta^2=.063$. All other main effects and interactions did not reach a level of significance [Prime Match Status: $F(1,69)=2.98$, $p=.089$, $\eta^2=.041$; Prime Duration x Prime Match Status: $F(1,69)=.897$, $p=.347$, $\eta^2=.013$; Study Status x Prime Duration: $F(1,69)=.237$, $p=.628$, $\eta^2=.003$; Study Status x Prime Duration x Prime Match Status: $F(1,69)=.008$, $p=.929$, $\eta^2<.001$

(See Figure 2)]. Again, these results may be partially explained by the idea that recollection contributes to the Jacoby-Whitehouse effect.

Cue Familiarity Ratings During Recall Success

Familiarity ratings were analyzed among test cues that did lead to successful retrieval of a similar study item via a repeated measures 2 (Study Status: studied target vs. unstudied target) x 2 (Prime Duration: 50ms vs 1000ms) x 2 (Prime Match Status: matching prime vs mismatched prime) analysis of variance (ANOVA). This analysis revealed a significant effect of Study Status, whereby test cues that resembled study items received higher familiarity ratings (*M*=8.67) than did test cues that did not resemble studied items (*M*=5.16), $F(1,69)=225.18$, $p<.001$, $\eta^2=.765$. No other main effects reached significance [Prime Duration: $F(1,69)=.425$, $p=.52$, $\eta^2=.006$; Prime Match Status: $F(1,69)=.20$, $p=.65$, $\eta^2=.003$]. A significant interaction was observed between Prime Duration and Prime Match Status, $F(1,69)=5.00$, $p=.03$, $\eta^2=.068$. When test cues and primes matched, familiarity ratings were higher for 50ms prime durations (*M*=7.09) than for 1000ms prime durations (*M*=6.80). However, a much smaller difference showing the opposite trend was found among prime durations when the primes did not match the test cues (50ms: *M*=6.81; 1000ms: *M*=6.97) (See Table 2, Figure 4).

Cue Familiarity Ratings During Recall Failure and the Recognition without Cued Recall (RWCR) Effect

An initial general analysis was performed to assess the data for the recognition without cued-recall (RWCR) effect that had been found in previous research, without considering the effects of prime match and prime duration. This effect was in fact apparent in the overall data with test cues that were graphemically and orthographically similar to items that had been on the study list eliciting significantly higher familiarity ratings (*M*=3.44, *SD*=1.57) than test cues that did not resemble studied items (unstudied) (*M*=2.02, *SD*=1.19) among test cues for which no similar study items could be identified, *t*(69)=10.02, *p*<.001 (See Figure 2).

To examine the RWCR effect in more detail, familiarity ratings for test items that resembled study items but were unable to be identified were compared across Match Status and Prime Duration. A 2 (Study Status: target studied vs target not studied) x 2 (Prime Match Status: match vs. mismatch) x 2 (Prime Duration: 50ms vs. 1000ms) repeated measures ANOVA was performed examining familiarity ratings for test cues that did not lead to successful retrieval of a similar study item across the independent variables. Overall, a significant three-way interaction was observed between these variables (Study Status x Prime Match Status x Prime Duration), *F*(1,69)=8.74, *p*=.004, η^2=.112. This pattern can be observed in Figure 5 and is prescriptive of long-duration mismatched primes lessening or weakening the effect of familiarity that is seen in all other conditions in which test cues resemble unrecalled studied items (See Table 3, Figure 5). Further analyses were carried out to isolate and try to understand the individual components that contributed to this interaction.

A significant main effect of Study Status emerged in these data; test cues that resembled study items elicited higher familiarity ratings (*M*=3.00, *SD*=1.57) than test cues that had no studied word counterparts (*M*=1.99, *SD*=1.19), *F*(1,69)=104.06, *p*<.001, η^2=.601. A main effect of Prime Match Status was observed such that familiarity ratings were higher overall for items that matched (*M*=2.73) than for those that did not match (*M*=2.26), *F*(1,69)=30.08, *p*<.001, η^2=.304. Significantly higher familiarity ratings were also seen for the short duration primes (*M*=2.63) versus the long duration primes (*M*=2.36), *F*(1,69)=11.11, *p*=.001, η^2=.139.

A significant interaction was observed between the Study Status and Prime Match Status variables; test cues that resembled studied items and followed a matching prime (*M*=3.44, *SD*=1.69) had higher familiarity ratings assigned to them than test cues that resembled studied items but followed mismatched primes (*M*=2.56, *SD*=1.65), whereas the relationship was not so distinguishable between prime match conditions among test cues that did not resemble items from study [matching prime: *M*=2.03; mismatched prime: *M*=1.96], $F(1,69)=26.48$, $p<.001$, $\eta^2=.277$. The Study Status by Prime Duration interaction also showed a significant relationship, $F(1,69)=11.06$, $p=.001$, $\eta^2=.138$. Among test cues that resembled studied items, those with a 50ms prime received higher familiarity ratings (*M*=3.29, *SD*=1.61) than those with 1000ms primes (*M*=2.71, *SD*=1.77). Of test cues that did not resemble studied items, those with 50ms (*M*=1.98) were met with only slightly lower familiarity ratings than those with 1000ms primes (*M*=2.01). To sum up, the RWCR effect was diminished in mismatched prime conditions as well as in 1000ms prime conditions. An interaction between Prime Match Status and Prime Duration came forth in the data as well; whereas the familiarity ratings did not change in the matching prime condition depending on duration (50ms prime: *M*=2.71; 1000ms prime: *M*=2.76), when the primes did not match the test cues, familiarity ratings were higher for test items that had a 50ms duration prime (*M*=2.56) as opposed to the 1000ms duration prime (*M*=1.96), $F(1,69)=26.40$, $p<.001$, $\eta^2=.277$ (See Table 3, Figure 6). Taken together, this again accentuates the pattern that the RWCR effect of higher familiarity ratings for test cues that resemble studied items is attenuated or impeded in the mismatched long duration (1000ms) prime condition.

Summary and Statement of the Problem

Considering the literature outlined above, novelty seems to be important for learning and memory. We see evidence for this through the way that we neurologically deal with novel information from our environments and then react behaviorally. Dual process models provide us with an account of recognition memory that is not unidimensional and possibilities of other processes involved in recognition have stemmed from research in this field. Occurrences of experience of familiarity coinciding with experience of novelty (such as in the experience of déjà vu) insinuate that different processes may be involved in these two types of experience. In addition, experiments that have investigated effects of priming and have tested models of semantic satiation, habituation, and fluency have provided some insight in to how we might observe and manipulate the subjective experience of novelty. Experiment 1 was designed to induce 'unfamiliarity' by creating overexposure to a test cue resembling a studied item. By first investigating whether these manipulations of fluency could alter the degree of the sense of familiarity (using the established rating scale for the RWCR paradigm), we could then attempt to approach novelty more directly to then investigate whether it is synonymous with unfamiliarity. Thus, this first study provided a start into the research, suggesting that the inhibition/interference mechanism explained by Neely (1976; 1977b) could potentially be an explanation for the results. However, measures of feelings of familiarity were the only measures used in Experiment 1 and in the previous literature investigating these effects. If it is possible that novelty, or a feelings of newness, is a separate subjective experience, perhaps the questions that are asked need to be framed differently to truly tap the target experience, such as by asking for feelings of novelty, rather than feelings of familiarity. Asking people for feelings of novelty, rather than familiarity, is important because an assumption inherent in many models (e.g., Rinkus, 2010) is that novelty is simply the inverse of familiarity (and not a separate or independent subjective experience).

Additionally, findings from Experiment 1 did not support the hypotheses and did not quite fit with the existing theories and models. There are several possible reasons for this. First, this study uses cues at the orthographic level of resemblance (or feature overlap from study to test), which, although included in Huber's (2008) model, has not previously been investigated to explore issues of habituation from cue repetition priming. Second, it is possible that the prime durations used in Experiment 1 were not long enough to elicit the habituation effect. In fact, the 50ms primes did not show the facilitation to familiarity ratings that would be expected based on the Jacoby-Whitehouse literature either, suggesting that either the prime durations selected may not have been optimal to exhibit the fluency-disfluency effects on recognition judgments, or these effects do not occur in situations of resemblance, where there is feature-overlap but the test items are not identical matches to studied items. In the latter case, it could mean that orthographic feature-overlap from study to test does not contribute as much to the fluency-disfluency process as lexical or semantic features. In any case, reconciling these findings and revealing the interplay between feelings of familiarity, feelings of novelty, and actual objective measures of recognition may provide additional insight into mechanisms of memory.

The pilot experiment (Experiment 1) gave some insight into whether mechanisms of saturation might reduce feelings of familiarity during retrieval failure; however, the experiment did not directly examine feelings of novelty. The next two experiments were aimed at addressing this, as well as to more closely inspect through replication the previous manipulations of prime match and duration. One major question investigated in Experiments 2 and 3 was whether novelty ratings exhibit the pattern that would be predicted if the sense of novelty is simply the inverse of familiarity. If novelty is the inverse of familiarity, then ratings of cue novelty during retrieval failure should show the inverse pattern of that shown with cue familiarity ratings. Also, although the opposite ratings pattern should emerge (with higher cue familiarity ratings for cues resembling than not resembling studied targets and *lower* cue novelty ratings for cues resembling than not resembling studied targets), the magnitude of the effect of cue resemblance to studied items should not depend on whether cue familiarity or cue novelty ratings are given. If the type of rating matters to the magnitude of the cue resemblance effect, this would suggest that there is more to the sense of novelty than it being the simple inverse of familiarity.

Another question examined in Experiment 2 was whether manipulation of prime duration and match to a test cue that potentially shares orthographic features with a study item reliably alters subjective experience for that study item. The main question was whether the prime match and duration pattern shown in Experiment 1 will replicate in Experiment 2, and if so, will this pattern extend to novelty ratings as well? If the pattern extends to novelty ratings, another question concerns whether the novelty ratings pattern will be the inverse of that shown with familiarity ratings. Based on the findings of Experiment 1, if novelty ratings manifest as the inverse of familiarity ratings, then we would expect long duration mismatched primes to be met with higher novelty ratings of the test cue than when no primes are present, whereas lower novelty ratings would be expected in response to test cues preceded by short primes as opposed to a condition with no primes. However, it is possible that the use of the novelty rating scale itself could result in a satiation effect, and if this is the case, it will be the matching long duration primes that will lead to an increased feeling of novelty and higher novelty ratings.

EXPERIMENT 2

The primary purpose of Experiment 2 was to replicate Experiment 1 with the addition of a new rating scale, novelty ratings (or feeling of newness ratings) in order to determine if judging the familiarity versus the novelty of the test cue makes a difference to the pattern of results. Toward this end, some participants were asked to provide ratings of feeling of newness (novelty ratings) rather than ratings of feeling of familiarity. A between-subject rating type condition was utilized, whereby half of the participants were asked to respond with familiarity ratings, as was the case in Experiment 1, and half were asked to respond with novelty ratings to test whether the type of ratings requested tap different processes or if feelings of novelty are the inverse of feelings of familiarity.

Method

Participants

One hundred seventy Colorado State University undergraduate students were recruited from the CSU Psychology Department subject pool and given course credit as a part of their introductory Psychology course requirements for participation in this study. Six subjects were dropped due to not completing the experiment (in most cases this was due to the computer crashing mid experiment, in one case the participant started the experiment late and was not able to complete the experiment in the alloted time) . Each subject identified as fluent in English. Informed consent was obtained from each participant. Subjects were divided into the rating type between-subject groupings by random assignment. This resulted in 164 participants, 78 in the familiarity rating scale group and 86 in the novelty rating scale group. The uneven number of participants in the two rating conditions was the result of: 1) a disproportionate number of dropped subjects coming from the familiarity condition, and 2) Two subjects mistakenly being run through a version of the Novelty rating experiment rather than the intended Familiarity rating experiment. Each subject was run through the study in an individual room.

Materials

All stimuli were presented visually on a computer. The stimuli used for the behavioral task were drawn from the same pool of 192 potential study words and the corresponding graphemically similar test cues (e.g., disfraption for the study word distraction, and foneheed for the study word forehead) that was used in Ryals and Cleary (2012) and Experiment 1. The stimuli were assembled in an E-Prime program that was presented to participants. Study and test stimuli were separated into six study-test blocks for each participant, each containing 16 study words followed by 32 test cues. Half (16) of the test cues resembled study items and half (16) did not. Order of presentation of study and test stimuli was randomized within each block and block presentation was also randomized.

Each study word was presented in the upper left corner of the computer screen for 2 s with a 1 s inter-stimulus interval. Each study list was immediately followed by its corresponding test list. Each non-word test cue was presented in lower case letters in the upper left corner of the screen. Test cues were each preceded by a prime that flashed in varying durations; a 50ms prime was presented in half of the primed trials (16) and a 1000ms prime occurred in the other half of trials (16). Fifty millisecond primes flashed only once before the test cue. 1000 millisecond primes flashed in 20 50ms intervals with 50ms between each flash before the test cue. A 500ms mask ($$$$$$$$$$$) was used before and after the prime to deter "visual persistence," and presentation of the test cue immediately followed the post-prime mask. Additionally, half of these primes matched the non-word test cue that followed it (16) and half did not (16). Prime duration and match conditions were counterbalanced among item assignment.

Procedure

Participants were greeted and given a consent form to compete before beginning the experiment. Upon completion, each was escorted to an individual booth in which the E-Prime program was set up on the computer for the participant to begin. Instructions were given on the screen and participants progressed through the program by pressing 'enter'. Instructions were given within the program. Then the participants progressed through six blocks of study-test pairs. During study, participants were instructed to pay attention to the words presented in the upper left corner of the screen and that a test would follow the study phase. Participants were randomly assigned to one of two ratings conditions: The familiarity rating condition and the novelty rating condition. These two conditions are described below.

Familiarity Rating Condition. Congruous with the procedures of the pilot, for each cue presented on the test, participants were first asked to provide a familiarity rating for that cue using a 0 (very unfamiliar) to 10 (very familiar) scale to indicate the likelihood that the cue resembled a word from the previously studied list. They were then asked if they could recall a word from the study list that resembled the test cue and were prompted to type their response into a dialogue box if able to do so. The box prompted them with: “Do you recall a word from the study list that resembles this item? If so, type it in.”

Novelty Rating Condition. For each cue presented on the test, participants were first asked to provide a novelty rating of the test cue itself. They were told that all of the test cues are non-words, so all are new, but that we would like them to indicate how foreign that cue seems at presentation. They were asked to rate the 'feeling of newness' using the scale of 0 (does not feel new) to 10 (feels very new). Following the rating, participants were asked, “Do you recall a word from the study list that resembles this item? If so, type it in.” Participants were prompted to type the studied word into a dialog box.

Results

Data Analyses

Data were sorted and coded for identification status of the test stimuli. This was done by hand to ensure that any misspellings were correctly categorized. One dependent measure was the proportion of targets correctly identified from the orthographic cues for studied and non-studied items across conditions. The other was the ratings measure (either mean familiarity ratings or mean novelty ratings) across conditions. The ratings were examined across the conditions of Rating Type (familiarity vs. novelty ratings), Study Status (target studied vs. unstudied), Prime Duration (50 ms vs. 1000 ms), Prime Match (match vs. mismatch to the test cue), and Retrieval Status (target identification success vs. failure).

The Recognition without Cued Recall (RWCR) Effect

As one of the key interests in the study was the pattern of ratings in instances of recall failure, an initial analysis was conducted to assess the data for the recognition without cued-recall (RWCR) effect across both rating conditions (familiarity ratings and novelty ratings). The RWCR effect is the finding of higher cue familiarity ratings for cues resembling studied items than for cues not resembling studied items during retrieval failure. The RWCR effect is thought to reflect cue familiarity-detection brought on by cue resemblance to (or feature overlap with) a studied item during the studied item’s retrieval failure. This effect had been demonstrated in previous research and in the pilot study through the observation that test cues resembling unidentified study items were rated as significantly more familiar than test cues that do not resemble study items. A 2

(Rating Type: familiarity ratings vs novelty ratings) x 2 (Study Status: target studied vs target unstudied) repeated measures analysis of variance (ANOVA) was performed with Rating Type as the between-subject factor, Study Status as the within-subject variable and ratings as the dependent variable. This analysis revealed a main effect of Rating Type; familiarity ratings (M=2.88, SD=1.40) were lower in general than novelty ratings (M=6.80, SD=1.57), $F(1,162)=305.61$, $p<.001$, $\eta^2=.65$.

The main effect of Study Status was also found to be significant. Overall, ratings were higher across both rating types for test cues that resembled study items (M=5.02, SE=.12) than for test cues that did not (M=4.67, SE=.11), $F(1,162)=25.70$, $p<.001$, $\eta^2=.25$. However, this was carried largely by the familiarity rating condition, as the main effect of Study Status was qualified by a significant Rating Type x Study Status interaction, $F(1,162)=165.30$, $p<.001$, $\eta^2=.51$. Within the familiarity rating condition, test cues that were orthographically similar to study items gave rise to significantly higher familiarity ratings (M=3.45, SD=1.54) than did test cues that did not resemble studied items (unstudied) (M=2.25, SD=1.33) among test items for which no similar study items could be identified. Within the novelty rating condition, orthographically similar test cues brought forth lower novelty ratings (M=6.46, SD=1.73) than did dissimilar test cues (unstudied) (M=6.98, SD=1.72) among test cues for which no similar study items could be identified (See Figure 7).

To assess whether the magnitude of the difference between ratings for cues of studied and of unstudied target words differed across rating conditions, difference values were calculated in each rating condition between ratings assigned to studied cues and those assigned to unstudied cues. The absolute value was taken of each of these difference values to account for the interaction effect described above (e.g., in the familiarity rating condition, studied cues correspond with high ratings and unstudied cues with low ratings, and vice versa in the novelty rating condition) (See Figure 8 for a distribution of these values). A one-way ANOVA was performed to investigate the difference between the familiarity rating absolute difference values and the novelty rating absolute difference values, revealing that the difference in ratings for cues of studied items and cues of unstudied items in the familiarity rating condition (M=1.28, SD=.95) was significantly larger than the difference in ratings for cues of studied items and cues of unstudied items in the novelty rating condition (M=.68, SD=.58), $F(1, 162)=24.15$, $p<.001$, $\eta^2=.13$. Thus, the study-status of the unidentified target had a larger effect on judgments of familiarity than on judgments of novelty. This suggests that novelty judgments are not simply the inverse of familiarity judgments.

The Effects of Prime Match and Duration

The next sections separately examine how the familiarity and novelty ratings were affected by the conditions of Prime Match and Prime Duration. Familiarity and novelty ratings will be examined separately, starting with familiarity ratings given during recall success then turning to familiarity ratings given during recall failure, followed by novelty ratings given during recall success then turning to novelty ratings given during recall failure.

Cue Familiarity Ratings During Recall Success. Familiarity ratings were analyzed among test cues that did lead to successful retrieval of a similar study item via a repeated measures 2 (Study Status: studied target vs. unstudied target) x 2 (Prime Duration: 50ms vs 1000ms) x 2 (Prime Match Status: matching prime vs mismatched prime) analysis of variance (ANOVA). This analysis revealed a significant effect of Study Status, whereby test cues that resembled study items received higher familiarity ratings (M= 8.83, SD= 0.88) than did test cues that did not resemble studied items (M=5.21, SD=2.62), $F(1,78)=245.20$, $p<.001$, $\eta^2=.759$. No other main effects reached significance [Prime Duration: $F(1,78)=2.59$, $p=.11$, $\eta^2=.032$; Prime Match Status: $F(1,78)=.008$, $p=.93$, $\eta^2=<.001$] nor did any interactions among variables [Study Status x Prime Match Status: $F(1,78)=.003$, $p=.96$, $\eta^2<.001$; Prime Duration x Prime Match Status: $F(1,78)=.112$, $p=.74$, $\eta^2=.001$; Study Status x Prime Duration: $F(1,78)=.18$, $p=.67$, $\eta^2=.002$; Study Status x Prime Duration x Prime Match Status: $F(1,78)=.122$, $p=.73$, $\eta^2=.002$] (See Table 4, Figure 9).

Cue Familiarity Ratings During Recall Failure. To examine whether and how the Prime Duration and Prime Match conditions affected the RWCR effect, cue familiarity ratings for test cues that resembled unidentified study items were compared across Prime Match and Prime Duration. A 2 (Study Status: target studied vs target unstudied) x 2 (Prime Match Status: match vs. mismatch) x 2 (Prime Duration: 50ms vs. 1000ms) repeated measures ANOVA was performed on cue familiarity ratings for test cues that did not lead to successful retrieval of a similar study item. The data exhibited a significant main effect of Study Status, such that test cues that resembled unidentified study items elicited higher familiarity ratings ($M=3.45$, $SD=1.54$) than test cues that had no studied word counterparts ($M=2.25$, $SD=1.33$), $F(1,77)=111.44$, $p<.001$, $\eta^2=.591$.

No other main effects reached significance [Prime Duration: $F(1,77)=.18$, $p=.68$, $\eta^2=.002$; Prime Match Status: $F(1,77)=1.21$, $p=.28$, $\eta^2=.015$] nor did any interactions among variables [Study Status x Prime Match Status: $F(1,77)=1.68$, $p=.20$, $\eta^2=.021$; Prime Duration x Prime Match Status: $F(1,77)=1.07$, $p=.30$, $\eta^2=.014$; Study Status x Prime Duration: $F(1,77)=.162$, $p=.69$, $\eta^2=.002$; Study Status x Prime Duration x Prime Match Status: $F(1,77)=.831$, $p=.365$, $\eta^2=.011$] (See Table 5, Figure 10).

Cue Novelty Ratings During Recall Success. Cue novelty ratings given in the presence of cued recall and novelty ratings given to test cues that did not lead to successful cued recall were analyzed separately to examine how the novelty ratings diffuse into the RWCR effect (or if they do). Novelty ratings were analyzed among test cues that led to successful retrieval of a similar study item via a repeated measures 2 (Study Status: studied target vs. unstudied target) x 2 (Prime Duration: 50ms vs 1000ms) x 2 (Prime Match Status: matching prime vs mismatched prime) analysis of variance (ANOVA). This analysis revealed a significant effect of Study Status, whereby test cues that resembled study items received lower cue novelty ratings (M=2.23, SD=1.60) than test cues that did not resemble studied items (M=3.61, SD=2.20), $F(1,85)=47.06$, $p<.001$, $\eta^2=.356$. The difference between Prime Match conditions approached significance, $F(1,85)=3.30$, $p=.07$, $\eta^2=.037$, with matching primes resulting in lower novelty ratings (M=2.85, SD=1.83) than mismatched prime conditions (M=3.00, SD=1.98) regardless of Study Status or Prime Duration condition. No significant difference was observed between short and long durations (main effect of Prime Duration), $F(1,85)=.039$, $p=.84$, $\eta^2<.001$. None of the interactions reached significance [Study Status x Prime Match Status: $F(1,85)=.451$, $p=.50$, $\eta^2=.005$; Study Status x Prime Duration: $F(1,85)=.242$, $p=.62$, $\eta^2=.003$; Prime Match Status x Prime Duration: $F(1,85)=.56$, $p=.46$, $\eta^2=.007$; Study Status x Prime Match Status x Prime Duration: $F(1,85)=1.86$, $p=.18$, $\eta^2=.021$] (See Table 6, Figure 11).

Cue Novelty Ratings During Recall Failure. Cue novelty ratings for cues that resembled unrecalled study items and unidentified unstudied items were compared across Prime Match status and Prime Duration. A 2 (Study Status: studied target vs. unstudied target) x 2 (Prime Duration: 50ms vs 1000ms) x 2 (Prime Match Status: matching prime vs mismatched prime) repeated measures ANOVA was performed on cue novelty ratings given during target retrieval failure.

A significant main effect of Study Status was shown; test cues that resembled study items elicited lower novelty ratings (M=6.53, SD=1.85) than test cues that had no studied word counterparts (*M*=7.05, *SD*=1.65), $F(1,85)=42.07$, $p<.001$, $\eta^2=.331$. No other main effects reached significance [Prime Duration: $F(1,85)=2.24$, $p=.14$, $\eta^2=.026$; Prime Match Status: $F(1,85)=.59$, $p=.45$, $\eta^2=.007$]. None of the interactions between variables reached significance [Study Status x Prime Match Status: $F(1,85)=.439$, $p=.51$, $\eta^2=.005$; Study Status x Prime Duration: $F(1,85)=1.07$, $p=.30$, $\eta^2=.012$; Prime Match Status x Prime Duration: $F(1,85)=.032$, $p=.86$, $\eta^2<.001$; Study Status x Prime Match Status x Prime Duration: $F(1,85)=.161$, $p=.69$, $\eta^2=.002$] (See Table 7, Figure 12).

Successful Recall Proportions

Identification proportions within each independent variable condition were calculated. A 2 (Rating Type: Familiarity ratings vs. Novelty ratings) x 2 (Study Status: target studied vs. target unstudied) x 2 (Prime Duration: 50ms prime vs. 1000ms prime) x 2 (Prime Match Staus: Match vs. Mismatch) repeated measures ANOVA was conducted to analyze the proportion of study items the participants were able to identify across each of these conditions.

A main effect of Study Status was observed by which higher proportions of correct target identifications were observed when test cues resembled studied items (*M*=.67, *SD*=.15) than when test cues did not resemble items from the study list (*M*=.24, *SD*=.16), $F(1,164)=1340.33$, $p<.001$, $\eta^2=.891$. A significant interaction between Study Status and Rating Type was also observed, $F(1,164)=10.14$, $p=.002$, $\eta^2=.058$; mean recall proportions for unstudied items in the novelty rating condition (*M*=.27, *SD*=.17) is higher than those in the familiarity rating condition (*M*=.20, *SD*=.14).

Contrary to the results observed in Experiment 1, however, the present analysis did not reveal a main effect of Prime Duration, $F(1,164)=1.17$, $p=.28$, $\eta^2=.007$, nor a significant Study Status x Prime Match Status interaction, $F(1,164)=.96$, $p=.33$, $\eta^2=.006$. All other main effects and interactions also did not reach a level of significance [Rating Type: $F(1,164)=2.14$, $p=.15$,

η^2=.013; Prime Match Status: F(1,164)=1.56, p=.21, η^2=.009; Rating Type x Prime Match Status: F(1,164)=.368, p=.55, η^2=.002; Rating Type x Prime Duration: F(1,164)=.737, p=.39, η^2=.004; Prime Duration x Prime Match Status: F(1,164)=1.77, p=.19, η^2=.011; Study Status x Prime Duration: F(1,164)=1.03, p=.31, η^2=.006; Study Status x Rating Type x Prime Match Status: F(1,164)=.355, p=.552, η^2=.002; Study Status x Prime Duration x Rating Type: F(1,164)=1.33, p=.25, η^2=1.33; Rating Type x Prime Duration x Prime Match Status: F(1,164)=.396, p=.53, η^2=.002; Study Status x Prime Duration x Prime Match Status: F(1,164)=.011, p=.918, η^2<.001; Rating Type x Study Status x Prime Duration x Prime Match Status: F(1,164)=.611, p=.434, η^2=.002 (See Tables 8 & 9, Figures 13 & 14)].

Discussion

The Recognition without Cued Recall (RWCR) Effect

The standard recognition without cued recall (RWCR) effect was observed by which test cues that resembled study items were given higher familiarity ratings than test cues that did not resemble study items. As expected, an inverse of this effect was observed in the novelty rating condition; test cues that resembled study items were given lower novelty ratings than test cues that did not resemble study items. However, the degree of this effect differed between the two rating types. The RWCR effect was significantly smaller in the novelty rating condition, meaning that the difference in the novelty ratings assigned to test cues that resembled study items and test cues that did not resemble study items was not as large as it is when a subject is asked to give familiarity ratings.

Two factors might be considered in deciding whether novelty ratings are the inverse of familiarity ratings, basically representing unfamiliarity: 1) One may be that the relationship between ratings given to studied items and unstudied items is reversed. This is very much the case. The pattern of higher ratings assigned to studied items and lower ratings given to unstudied items in the familiarity rating condition is reversed in the novelty rating condition where lower ratings are ascribed to studied items and higher ratings to unstudied items. 2) The other is that the magnitude of that relationship is consistent across rating conditions or the degree of difference is mirrored in the conditions. Our analysis of the absolute differences of ratings between study status in both rating conditions reveals that this pattern does not occur in the data.

Taken together, the results regarding these two factors could suggest that familiarity ratings and novelty ratings have some common basis, perhaps some sense of prior experience. However, in considering subjective experiences of familiarity and novelty, the difference in the relationship between previously experienced and new items among the rating scales suggests that one is not simply the inverse of the other. It may be that the factors that contribute to these experiences and lead to these judgments vary between familiarity and novelty.

The Effects of Prime Match and Prime Duration on Cue Familiarity and Novelty Ratings

Familiarity Ratings. The duration of the prime presented before the cue did not seem to have an effect on the ratings given; nor did whether the prime matched the test cue or was a new nonword. These results were inconsistent with the results of Experiment 1 which suggested a unique effect in that the mismatched long (1000ms) primes produced lower familiarity ratings than the matching primes (both short and long) and mismatched short primes for test cues that resembled studied words while leaving ratings of new test cues relatively unaffected. The current data did not support the semantic satiation hypothesis, the interference or inhibition hypothesis, nor did it support Huber's fluency-disfluency model. In fact, no significant differences existed among these conditions, which suggests that familiarity ratings for test cues can not be manipulated through duration of exposure to those cues and that prolonged exposure to a test cue does not disrupt the recognition rating benefit that cue gets when it resembles a word from a previously studied list.

The fact that the classic Jacoby-Whitehouse effect was not observed in this data nor the pilot data (Experiment 1) is puzzling. To observe this effect, we would have seen the test cues for which there was a matching 50ms prime exhibiting a higher familiarity rating than that of all other conditions. These findings can be added to those of literature that have found instances in which the Jacoby-Whitehouse effect is reduced or eliminated. For instance Gallo, Perlmutter, Moore, and Schacter (2008) found that conditions present at study can reduce the effect. In their experiment, subjects were presented with the word followed by either a picture of the word or an auditory presentation of the word at study and, at test, matching primes produced higher hit and false alarm rates in the auditory condition, displaying the effect, but matching primes produced similar recognition rates as the mismatched primes in the picture condition and false alarm rates were reduced in this condition overall. The authors attribute this to a postretrieval monitoring view of the distinctiveness heuristic – recognition judgments follow attempts to retrieve the picture recollections. When subjects fail to recollect a picture, they judge the cue as new, but when they are able to recollect a picture, that cue is given an 'old' judgment (Gallo, Perlmutter, Moore, & Schacter, 2008).

The present experiment varied from previous studies that used a paradigm similar to the Jacoby-Whitehouse paradigm in that orthographic features were the only attribute maintained from study to test; test cues did not replicate study words. This may be an explanation for why we did not observe these classic effects in the current data. Similarly, it may be considered a factor that weakens the effects and future experiments may be useful in investigating this orthographic level further.

Novelty Ratings. Novelty ratings were generally lower for test cues that resembled study items and higher for test cues that did not resemble any words previously studied. This pattern persisted when identification of study items was not successful as well. Novelty ratings were also lower for test cues for which corresponding study words were identified than for those for which the similar study words were not identified. These results are not surprising and support the reverse relationship to familiarity ratings that was discussed earlier.

Of some interest is that in the instances in which successful recall of similar study words occurred, the prime match condition had some influence (although not statistically significant) on the rating given to the test cue. A slightly lower rating was given when the primes matched than when the primes did not match the test cue. This may be a variant manifestation of the Jacoby-Whitehouse effect. Perhaps the matching prime gave the participant a head start to retrieve that target word from study, thus resulting in that lower rating. It is possible that this was not the case in the conditions when the subject was not able to identify the study word that looked similar to the nonword presented at test because the cue did not successfully activate any memory representations corresponding to studied words.

Successful Recall Proportions

In examining proportions of successful recall, again we find an effect of whether a test cue resembled a study word or not. A higher proportion of study words were recalled when the test cue was orthographically similar to a studied word. While the identification proportions of study words remain relatively similar among those that had a presented similar test cue across rating conditions, correct guesses (by which subjects were able to identify correct study words after presented with the test cue even though they did not study that word) were slightly more frequent (~.07) in the novelty rating condition. It may be that something about the framing of the rating request allows for a different experience of the cue and an openness to assess the cue by similar features to all words (not just those presented in the study phase of the experiment).

These results did not mimic those of Experiment 1. The experiment 1 data suggested an effect of prime duration that manifested in proportion of study words recalled. However, no effect of prime duration or prime match status was observed in the data of the present study.

Limitations

One limitation for this study was that the number of items that lead to mean ratings is highly dependent upon the number in each established category that are identified (See Table 10), which often leads to a low number of items in certain conditions providing the basis for the mean ratings. Additionally, it is unclear what led to the differences in results between Experiment 1 and Experiment 2. Very few changes were made in procedures between the two. This discrepancy in the data should be explored further in additional experiments as should the failure again in Experiment 2 to find the Jacoby-Whitehouse effect.

EXPERIMENT 3

Experiment 3 addressed the general research questions outlined in the introduction while incorporating a new component, verbal pronunciation and repetition. Research addressing early language acquisition suggests that phonological accompaniment to orthographic cues facilitates learning the orthographic features of new words (Share, 2004). Orthographic representations are said to be initially acquired or learned by 'sounding out' the unfamiliar formation of letters (or phonologically decoding) (Share, 2004). Consequently, it may be that if exposure to shared orthographic features between study words and test cues are not salient enough to lead to any facilitation or hampering of recognition processing as is observed in the Jacoby-Whitehouse effect and the disfluency effect in habituation, addition of a phonological component, highly linked to orthographic and semantic information, may capacitate these effects.

Evidence for this can be seen in the findings in Neely's (1977a) work that had subjects in two conditions: one group exposed to *visual satiation* of a word that either matched or did not match the prime that appeared before the target in a lexical decision task, and the other group subjected to *both visual satiation and verbal satiation.* Verbal satiation of the primes significantly increased reaction times in the lexical decision task for the target words that followed (Neely, 1977a, p. 455). This implies that addition of verbal satiation of the primes further interrupted recognition processing and, consequently, amplified the satiation effect.

This is echoed in James' original work on semantic satiation (1962). In this work, subjects were presented with a word for one second and were then asked to verbally repeat that word for 15 seconds thereafter. They were also instructed that the rate of repetition should be about 2-3 repetitions per second and then rate the word on an index of meaningfulness. In contrast, one control condition involved the initial word presentation and then 15 seconds they were instructed to wait to make a rating. The other control condition involved the subjects repeating a word for 15 seconds and then judging an alternate word using the scale. Results exhibited ratings closer to 'meaningless' point on the scale when the subjects had to repeat the same word aloud that they would be judging (James, 1962).

The above studies support the idea that verbal repetitions can alter semantic accessibility. Having verbal regurgitation of the test cues may also lead to differential outcomes on an orthographic level due to the process engaging verbal generation rather than solely passive viewing to produce the exposure to the test cues. Given that Experiment 2 failed to find any effect of primes on familiarity or novelty ratings, the engagement of deeper cue processing in Experiment 3 might encourage semantic-level processing of the cue and thus increase the likelihood of finding an effect of the primes, such as the Jacoby-Whitehouse effect. Also, because other research has suggested that processing fluency may be driven or enhanced by the motor processes involved in overt pronunciation (e.g., Topolinski, 2012), there is additional reason to suspect that overt repetition might increase the likelihood of an over-saturation effect. Accordingly, the focused research questions that Experiment 3 was designed to address are: How will verbal repetition of nonword test cues affect feelings of novelty for those cues? In other words, will an oversaturation effect occur for test cues that are repeated thirty times versus only once? In addition, how will recollection for the graphemically similar study word be affected?

The paradigm employed in Experiment 3 was reformatted from that of Experiment 2 to include verbal repetition of test nonwords to see how this difference in task and modality would affect novelty ratings for nonword test cues and recognition of similar study items. Expectations were that incorporations of a phonological component into the experimental paradigm would lead to different mechanisms employed within the task and, consequently, different patterns of data or would exacerbate existing patterns that were too weak to come through in the first experiment. Novelty ratings were expected to be higher for test cues which graphemically resembled study items but were verbally repeated multiple times versus only one time.

Method

Participants

Twelve Colorado State University undergraduate students were initially recruited from a Psy 459 Cognitive Neuroscience Laboratory and offered extra credit for the course to participate in a pilot intended to test the whether the nonwords used in the experiment for the test cues were pronounceable. For the main study, eighty five Colorado State University undergraduate students were recruited from the CSU Psychology Department subject pool and given course credit as a part of their introductory Psychology course requirements for participation in this study. Thirteen subjects were dropped due to incompletion of the experiment or program malfunctions during the course of the experiment, leaving 72 participants, 36 in the familiarity rating condition and 36 in the novelty rating condition. Each participant in both the pilot and Experiment 3 identified as fluent in English and gave informed consent. Each subject ran through the study in an individual room with a researcher present.

Materials

Pilot. The pilot materials were assembled with the same test cues that were used in Experiment 1 and that were consequently used in Experiment 2. These test cues were collected in an E-Prime program, which presented the cues one at a time in the upper left corner of the screen. Order of presentation was randomized. The duration that the cue was presented was controlled by the participant by pressing 'Enter' to move on to the next cue.

Experiment 3. All stimuli were the same as that described in Experiment 2 (the 192 potential study words and graphemically similar test cues used in Ryals and Cleary (2012)). Again, the stimuli were put together in an E-Prime program that was presented to participants. Study and test stimuli were separated into six study-test blocks for each participant, each containing 16 study words followed by 32 test cues. Half (16) of the test cues resembled study items and half (16) did not. Order of presentation of study and test stimuli were randomized within each block and block presentation was randomized.

Each study word was presented in the upper left corner of the computer screen for 2 s with a 1 s inter-stimulus interval. Each study list was immediately followed by the corresponding test list. Test nonwords appeared in the upper left corner of the computer screen and a repetition cue was presented in the center of the screen. Half of the test cues were accompanied by repetition cues that were the number 30, indicating that the subject should verbally say the nonword 30 times. The remaining half of test cues were paired with the number 1 as the cue, indicating the subject should repeat the test nonword out loud only once. The test cue remained on the screen for the duration of the verbal repetitions.

Procedure

Pilot. An initial pilot was carried out before Experiment 3 to ensure that subjects would be able to say the nonwords aloud. For this pilot, each nonword was presented in the top left corner of the screen and the participant was instructed to say the nonword aloud when it appeared. The pilot was paced by the participant; the cue would remain on the screen until the participant pressed the 'Enter' key, at which point the next cue would appear. No judgments were made in the pilot, nor was there a study phase.

Experiment 3. Participants were greeted and given a consent form to complete before beginning the experiment. Upon completion, each was escorted to an individual booth in which the E-Prime program was set up on the computer for the participant to begin. Experimenters were present in the room with the participant to ensure that the participant was making verbal responses. Responses were also recorded. Instructions were given on the screen and participants were to progress through the program by pressing 'enter'. During study, the participants were instructed to pay attention to the words presented in the upper left corner of the screen and that a test would follow the study phase.

Familiarity rating condition. For each cue presented on the test, participants were first asked to use the repetition cue and to say that nonword test cue out loud for the number of times that the repetition cue indicated. Participants were instructed to press enter upon completion of the verbal repetitions of the nonword and, when they did so, a dialogue box appeared asking them first to provide a rating for 'feeling of familiarity' of the test cue itself. They were told that we would like them to indicate how familiar the test cue feels to them at the time of presentation. They were asked to rate the 'feeling of familiarity' using the scale of 0 (does not feel familiar) to 10 (feels very familiar). Following the rating, participants were asked, ‘‘Do you recall a word from the study list that resembles this item? If so, type it in.’’ Participants were prompted to type the studied word into a dialog box.

Novelty rating condition. For each cue presented on the test, participants were first asked to use the repetition cue and to say that nonword test cue out loud for the number of times that the repetition cue indicated. Upon completion of the verbal repetitions of the test cue, participants were to press enter. A dialogue box would appear at their key press asking them first to provide a rating for 'feeling of newness' of the test cue itself. They were told that all of the test items are non-words, so all are new, but that we would like them to indicate how foreign that cue feels to them at the time of presentation. They were asked to rate the 'feeling of newness' using the scale of 0 (does not feel new) to 10 (feels very new). Following the rating, participants were asked, “Do you recall a word from the study list that resembles this item? If so, type it in.” Participants were prompted to type the studied word into a dialog box.

Results

Pilot Assessment

The verbal responses obtained from the 15 pilot subjects were observed at the time of collection by the researcher. If there were any of the nonword cues that a subject was not able to say out loud, the researcher would take note of it. Any nonwords that were particularly difficult for the subject to say were also recorded within each subjects' data. There were no cues among all 15 pilot subjects which were unable to be vocalized. There were nonword cues that seemed to take longer than others, but the particular items varied among the subjects.

Data Analyses

Typed identification responses were sorted and coded for identification status of the test stimuli. This was done by hand to ensure that any misspellings were correctly categorized. The mean number of items correctly identified for studied and non-studied items across all conditions and the mean familiarity and novelty ratings given to test cues for studied and non-studied items were calculated.

The recordings of verbal responses were listened to to make sure the participants were correctly following the instructions. They were assessed for any instances in which the participant may not have said the cue aloud the correct number of times. Any other verbal discrepancies from the intended cue to be repeated or times that the researcher had to intervene to correct or ensure that the participants were saying the words and following direction were counted for each participant.

The Recognition without Cued Recall (RWCR) Effect

Again for Experiment 3, we were primarily interested in ratings when recall failed. The recognition without cued-recall effect across both rating conditions (familiarity ratings and novelty ratings) was investigated through the use of a 2 (Rating Type: familiarity ratings vs novelty ratings) x 2 (Study Status: studied vs unstudied) repeated measures analysis of variance (ANOVA). The effect of Rating Type was observed between subjects, Study Status was the within-subject variable and ratings were the dependent variable. This analysis revealed a main effect of Rating Type; familiarity ratings (M=2.51, SD=1.64) were lower in general than novelty ratings (M=7.08, SD=1.89), $F(1,70)=127.14$, $p<.001$, $\eta^2=.62$.

The main effect of Study Status was not significant, with ratings across both rating types for test cues that resembled study items only slightly higher (M=4.82, SD=2.78) than for test cues that did not (M=4.70, SD=3.01), $F(1,71)=1.26$, $p=.266$, $\eta^2=.25$. However, this lack of main effect was likely due to the fact that the Rating Type x Study Status interaction was significant such that the effect of Study Status depended on the type of rating being given, $F(1,69)=10.81$, $p=.002$, $\eta^2=.48$. As in Experiment 2, test cues that were orthographically similar to study items elicited significantly higher familiarity ratings (M=2.75, SD=1.68) than did test cues that did not resemble studied items (unstudied) (M=2.27, SD=1.58) among test cues for which no similar study items could be identified. As expected, the relationship within the novelty rating condition showed an effect of Study-Status in the opposite direction; orthographically similar test cues led to lower novelty ratings (M=6.96, SD=1.94) than did dissimilar test cues (unstudied) (M=7.20, SD=1.85) among test items for which no similar study items could be identified (See Figure 15).

The difference between ratings for studied and unstudied items were explored between rating conditions to further investigate the effects described above. The significant main effect of Rating Type along with the interaction suggest that there may be a difference in the magnitude of the RWCR effect. Difference values were calculated in each rating condition between ratings assigned to studied cues and those assigned to unstudied cues and the absolute value was taken of each of these difference values (see Figure 16 for distributions). A t-test revealed that the difference in ratings of studied items and unstudied items in the familiarity rating condition (M=.62, SD=.50) was significantly larger than the difference in ratings of studied items and unstudied items in the novelty rating condition (M=.40, SD=.35), $t(69)=2.18$, $p=.03$.

The Effects of Verbal Repetition

The next sections separately examine how the familiarity and novelty ratings were affected by the conditions of Repetition (repeated one time or 30 times). Familiarity and novelty ratings will be examined separately, starting with familiarity ratings given during recall success then turning to familiarity ratings given during recall failure, followed by novelty ratings given during recall success then turning to novelty ratings given during recall failure.

Cue Familiarity Ratings During Recall Success. Familiarity ratings were analyzed among test cues that did lead to successful retrieval of a similar study item via a repeated measures 2 (Study Status: studied target vs. unstudied target) x 2 (Repetition Condition: one time vs 30 times) analysis of variance (ANOVA). This analysis yielded a significant effect of Study Status, whereby test cues that resembled study items received higher familiarity ratings (M=8.48, SD=.89) than did test cues that did not resemble studied items (M=5.55, SD=2.03), $F(1,35)=85.32$, $p<.001$, $\eta^2=.71$. No effect of Repetition Condition was observed, $F(1,35)=.39$, $p=.54$, $\eta^2=.011$. The interaction between Study Status and Repetition Condition also did not prove to be significant, $F(1,35)=2.60$, $p=.12$, $\eta^2=.068$ (See Table 11, Figure 17).

Cue Familiarity Ratings During Recall Failure. To investigate how the number of times a subject said the test cue would factor in to the RWCR effect, familiarity ratings for test cues that resembled study items but were unable to be identified were compared across Repetition Condition. A 2 (Study Status: target studied vs target not studied) x 2 (Repetition Condition: 1 time vs. 30 times) repeated measures ANOVA was performed examining familiarity ratings for test cues that did not lead to successful retrieval of a similar study item. The effect of Study Status was significant with test cues resembling study items showing higher familiarity ratings ($M=2.75$, $SD=1.82$) than test cues that were not orthograpically similar to a studied word ($M=2.27$, $SD=1.61$), $F(1,35)=19.22$, $p<.001$, $\eta^2=.354$.

Similar to the findings of Experiment 2, no main effect of Repetition Condition was observed, $F(1,35)=.87$, $p=.36$, $\eta^2=.024$, nor was an interaction between Study Status and number of repetitions, $F(1,35)=0$, $p=.99$, $\eta^2=0$ (See Table 11, Figure 18).

Cue Novelty Ratings During Recall Success. Novelty ratings were analyzed among test cues that did lead to successful retrieval of a similar study item in a repeated measures 2 (Study Status: studied target vs. unstudied target) x 2 (Repetition Condition: 1 time vs 30 times) analysis of variance (ANOVA). From this, a significant effect of Study Status was observed, by which test cues that resembled study items received lower novelty ratings ($M=4.25$, $SD=2.53$) than did test cues that did not resemble studied items ($M=4.99$, SD=2.50), $F(1,35)=12.77$, $p=.001$, $\eta^2=.267$.

The effect of Repetition Condition was not found to be significant, $F(1,35)=.84$, $p=.37$, $\eta^2=.023$, although, in each study condition, the means were slightly higher when the cues were repeated 30 times (Studied: $M=4.33$, $SD=2.56$; Unstudied: $M=5.09$, $SD=2.60$) versus only once

(Studied: *M*=4.18, *SD*=2.50; Unstudied: *M*=4.88, *SD*=2.40). Finally, no interaction effect was observed between Study Status and Repetition Condition, $F(1,35)=.06$, $p=.82$, $\eta^2=.002$ (See Table 12, Figure 19).

Cue Novelty Rating During Recall Failure. A 2 (Study Status: target studied vs target unstudied) x 2 (Repetition Condition: one time vs. 30 times) repeated measures ANOVA was performed to explore novelty ratings for test cues that did not lead to successful retrieval of a similar study item. The effect of Study Status was found to be significant; test cues that resembled study items elicited lower novelty ratings (*M*=6.96, *SD*=1.94) than did dissimilar test cues (unstudied) (*M*=7.20, *SD*=1.85).

No significant effect was found for Repetition Condition, $F(1,35)=0$, $p=.99$, $\eta^2=0$; however, the interaction between Study Status and Repetition Condition approached significance, $F(1,35)=3.34$, $p=.076$, $\eta^2=.087$. This interaction can be observed in the means; test cues that resembled studied items and were said aloud only once (*M*=6.97, *SD*=1.95) had lower novelty ratings assigned to them than test cues that resembled studied items and were repeated 30 times (*M*=7.09, *SD*=2.11), whereas test cues that did not resemble items from study said once (*M*=7.34, *SD*=1.82) had slightly higher novelty ratings assigned to them than test cues in this condition that were repeated 30 times (*M*=7.21, *SD*=2.08) (See Table 12, Figure 20).

Successful Recall Proportions

Identification proportions within each independent variable condition were calculated. A 2 (Rating Type: familiarity ratings vs. novelty ratings) x 2 (Study Status: target studied vs. target unstudied) x 2 (Repetition Condition: one time vs. 30 times) repeated measures ANOVA was conducted to analyze the proportion of study items the participants were able to identify across each of these conditions. The effect of Rating Type was significant; higher proportions of correct target identifications were observed in the familiarity rating scale (*M*=.42, *SD*=.22) than in the novelty rating scale condition (*M*=.39, *SD*=.22), $F(1,70)=5.00$, $p=.03$, $\eta^2=.722$. Additionally, there was an effect of Study Status whereby higher proportions of correct target identifications were observed when test cues resembled studied items (*M*=.57, *SD*=.16) than when test cues did not resemble items from the study list (*M*=.24, *SD*=.14), $F(1,70)=376.00$, $p<.001$, $\eta^2=.801$.

No significant differences in identification proportions were found between repetition conditions (one time vs 30 times) overall, $F(1,70)=0$, $p=.99$, $\eta^2=0$, and no interactions among any of the variables were found in this global analysis [Rating Condition x Study Status: $F(1,70)=1.01$ $p=.32$, $\eta^2=.002$; Rating Type x Repetition Condition: $F(1,70)=.50$, $p=.48$, $\eta^2=.004$; Study Status x Repetition Condition: $F(1,70)=0$, $p=.99$, $\eta^2=0$; Study Status x Rating Type x Repetition Condition: $F(1,70)=0$, $p=.99$, $\eta^2=0$]. However, to explore the main effect of Rating Type in more depth, the proportions of correct identifications were analyzed in each of the rating scales separately.

Analysis of the identification proportions within the familiarity rating condition revealed only a main effect of Study Status, $F(1,35)=229.45$, $p<.001$, $\eta^2=.87$. Test cues that resembled words from the study list more often led to correct identifications of the study words (*M*=.59, *SD*=.14) than did test cues unlike any study words (*M*=.25, *SD*=.14). No effects were observed for the repetition variable, $F(1,35)=.87$, $p=.36$, $\eta^2=.024$, nor the interaction between Study Status and Repetition Condition, $F(1,164)=10.14$, $p=.002$, $\eta^2=.058$ (See Table 13, Figure 21).

Different patterns of results were observed when the identification proportions were analyzed among conditions within the novelty rating condition. Overall, test cues which were said aloud only once less often led to identifications of the corresponding study words (*M*=.39, *SD*=.16) than did test cues that were repeated aloud 30 times (*M*=.50, *SD*=.17), $F(1,35)=19.89$, $p<.001$, $\eta^2=.37$. Likewise, test cues that were orthographically similar to a presented study word led to significantly more identification proportions (*M*=.54, *SD*=.17) than did test cues with no study word similarities (*M*=.35, *SD*=.16), $F(1,35)=24.49$, $p<.001$, $\eta^2=.42$. The interaction between study status and repetition condition was also significant, $F(1,35)=21.22$, $p<.001$, $\eta^2=.38$, showing that identification proportions across conditions of repetition were similar when test cues resembled studied words (1x: *M*=.54, *SD*=.18; 30x: *M*=.54, *SD*=.17), but conversely, differed when test cues did not resemble any studied words (1x: *M*=.24, *SD*=.15; 30x: *M*=.45, *SD*=.17). Identification proportions were higher within this condition when the subjects repeated the test cues thirty times (See Table 13, Figure 22).

Discussion

The Recognition without Cued Recall (RWCR) Effect

Again for Experiment 3, the standard recognition without cued recall effect emerges in the familiarity rating condition, showing that test cues that resembled study items were given higher familiarity ratings than test cues that did not resemble study items. With novelty ratings, the reverse of this relationship was found; test cues that resembled study items were given lower novelty ratings than test cues that did not resemble study items. When analysis was done into the magnitude of the effect in each rating condition, however, again we found that the (reverse?) RWCR effect was significantly smaller in the novelty rating condition than in the familiarity rating condition. Novelty ratings do not display as much of a distinction between studied and unstudied items as familiarity ratings do.

These findings match those in the second experiment, which suggests that these effects persist across modalities of test cue presentation. However, both experiments included visual presentation and for Experiment 3, verbal repetitions were only a secondary form of test cue presentation, so it is possible that the observed effects were due solely to the visual presentation of those test cues. Despite the inability to bridge these findings to other sensory modalities, the findings do provide further support for the relationship between novelty ratings and familiarity ratings. The pattern of higher ratings assigned to studied items and lower ratings given to unstudied items in the familiarity rating condition is reversed in the novelty rating condition where lower ratings are ascribed to studied items and higher ratings to unstudied items, however, the degree of the difference between ratings assigned to studied items and those assigned to unstudied items is different between the two rating conditions.

The Effect of Verbal Repetition on Cue Familiarity and Novelty Ratings

Familiarity Ratings. In the presence of recall we only see an effect of study status; test cues that resembled studied items were given higher familiarity ratings than test cues that did not resemble any words presented at study. The number of repetitions of the nonword test cues had relatively no effect when cues gave rise to correct identifications of the study words. This same pattern of results is observed when subjects are not able to correctly identify a study word that corresponds to the test cue presented; test cues that resembled study words were still given higher familiarity ratings than test cues that had no similar study word presented. This, again, is the standard RWCR effect that we had expected to observe.

Of interest here is that the number of times the subject was instructed to repeat the nonword test cues seemingly had no effect on the familiarity of those cues. This would suggest that the number of verbal repetitions does not lead to a habituation effect as is described in the semantic satiation literature as well as is proposed in Huber's and colleagues (2008) fluency-disfluency model. To see this, the data would have shown lower familiarity ratings to test cues that had been repeated 30 times and familiarity ratings higher, similar to those when the subject just views the cues, in the conditions in which the participants had to only say the test cue aloud once. It is possible, like in Experiment 2, that this habituation can not be reached driven by orthographic features alone. This thought will be explored further in the general discussion that follows.

Novelty Ratings. In all identification conditions, test cues that resembled studied items led to lower novelty ratings than did test cues that did not share orthographic features with a word that had been presented at study. This could be considered a reversed RWCR effect and had been expected considering the reliable effect that persists within familiarity ratings. These findings, and those that show no difference among the number of times the cue is repeated, are consistent with the results of the second experiment.

The interaction that is observed between Study Status and Repetition Condition when study items resembling test cues are not identified is interesting (although it did not reach statistical significance). It could be that when the test cue does not resemble a word from the study list, the repetitions allow the subjects to generate other words from their general knowledge that do share features with the test cue, leading them to judge that cue as less new. Alternately, when a similar word had been presented in the study phase, perhaps the increased repetitions of the cue do lead to a saturation effect of those features which results in a higher novelty rating. A different trend was found when the corresponding study items were recalled from the test cue; whether the cue resembled a study item or not, the novelty ratings were higher for cues repeated 30 times. The effect size in both conditions was relatively small, however. It would be interesting to explore this in a follow up experiment with more participants to increase power.

Successful Recall Proportions

Overall, the rating scale used to make judgments (familiarity or novelty) affected the proportion of study items that were correctly recalled. A deeper inspection exposed that the difference driving the effect was primarily due to proportions within the familiarity rating condition being relatively stable across the repetition conditions while a difference emerged in the proportions within the novelty rating condition. Whether a test cue corresponded with a study word was not affected by the number of study words that were successfully recalled no matter the rating scale utilized; when test cues orthographically matched a study word, they were more likely to be correctly identified. However, subjects were more likely to identify the study word that orthographically matched the presented test cue, although the study word was not included in their study list (correct guesses), after repeating the cue 30 times. Fewer correct guesses were made when the test cue was only said aloud once. This effect was also observed in Experiment 2, although to a lesser degree.

Because this phenomenon is observed in both experiments, it seems that it is an effect of the rating scale (as it is not observed in the familiarity rating scale condition), but it also seems that verbal repetition may exacerbate the effect. It may be related to the finding discussed above, in the 'Novelty Ratings' section, of novelty ratings being lower for cues that do not resemble a word from the study list repeated 30 times, versus only once, when study items resembling test cues are not identified. It is possible that this condition (novelty ratings given to cues repeated 30 times) provokes lower ratings because the ability to come up with or internally generate a similar word to the test cue makes the test cue seem less new.

Limitations

One major limitation in this experiment was that the pace of the repetitions was not dictated by the experiment instructions. This resulted in a high degree of variability of pace across participants. It was observed in the audio data that some participants were much faster at saying the cues and some were much slower. This was also evident in the time it took participants to complete the experiment; some were complete in an hour and 15 minutes, while others struggled to complete within the 2 hour allotment. This variability could affect the way that each individual processed the stimuli and could have altered the effect. This also led to having to drop a number of subjects that were not able to complete the experiment.

Additionally, as in the previous experiments, ratings were driven by a low number of items in some of the experimental conditions. This occurs by nature of the paradigm used because one of the variables (identification status) can only be determined after the experiment is ran through coding of each participants data. This can lead to very few items actually leading to the mean rating in one particular condition (See Table 14).

GENERAL DISCUSSION

This study sought to address two general questions with respect to the sense of novelty. The first question was: How will novelty ratings compare to familiarity ratings? Much research has considered novelty only as the inverse of familiarity (Rinkus, 2010). This view suggests that, in the case of subjective ratings, a cue that feels very familiar would not feel very new and vice versa, and if asked to give the two different types of ratings (cue familiarity vs. cue novelty ratings), the patterns should be the inverse of one another. Specifically, the *degree* of familiarity elicited by a stimulus should be the inverse of the *degree* of novelty felt upon presentation of that same stimulus and that any factors that would influence one would similarly influence the other. The second general question that was asked was: Will repetition priming of the test cue itself change how that cue is experienced in terms of its elicited level of familiarity and novelty?

To address the first question (that of whether novelty is the inverse of familiarity), the results suggest that it is not. Although both Experiments 2 and 3 demonstrate that cues resembling studied items were rated higher in familiarity and lower in novelty than cues not resembling studied items, the magnitude of the resemblance effect differed depending on the type of rating being given. The magnitude of the cue resemblance effect was smaller when cue novelty ratings were given than when cue familiarity ratings were given. This pattern suggests that cue novelty ratings are not simply the inverse of cue familiarity ratings. There appears to be something different being invoked for judgments of novelty than for judgments of familiarity.

Further evidence for the idea that novelty ratings invoke other processes than do familiarity ratings is the finding that correct target guessing rates were higher among participants assigned to the novelty rating condition than among participants assigned to the familiarity rating condition. This pattern was shown in both Experiments 2 and 3 and was not predicted. However, the pattern suggests that orienting participants toward cue novelty judgments may prompt them to search harder for the target word in memory. Why should participants be more compelled to search memory for potential targets when oriented toward cue novelty than when oriented toward cue familiarity? One possibility is that being oriented toward novelty increases guessing attempts. However, a close examination of the response rates in both experiments did not consistently support this hypothesis. Participants in Experiment 2 indeed responded more often in the novelty ratings condition than in the familiarity ratings condition ($t(163)=-1.99$, $p=.048$), however, the opposite was found in Experiment 3 (See Table 15). This variability in response rates between experiments could be related to the trend for a repetition effect in Experiment 3 that is absent in Experiment 2.

Alternatively, the differences we see in ratings for orthographically similar cues across rating type might be explained by research that has investigated associative novelty in more depth. Kumaran and Maguire (2007) suggest that stimulus novelty and associative novelty may rely on different neural subsystems. While past studies suggest that stimulus novelty is detected and processed by the perirhinal cortex via a familiarity mechanism (Aggleton & Brown, 2006; Brown & Bashir, 2002; Viskontas et al., 2006), it is likely that associative novelty is detected and processed via a comparator mechanism taking place in the hippocampus (Kumaran & Maguire, 2007; Viskontas et al., 2006).

The distinction between these two computational mechanisms is as follows: Familiarity mechanisms operate by a familiarity/novelty discrimination system. When a stimulus is presented, a global matching process ensues and degree of match between it and other representations stored in memory creates a familiarity signal; the higher the degree of match, the higher the familiarity signal (Kumaran & Maguire, 2007; Norman & O'Reilly, 2003). This is the mechanism that is largely agreed to be the mechanism of novelty detection in the perirhinal cortex. The perirhinal cortex is also thought to work on a response reduction model; with each subsequent stimulus exposure, less perirhinal activation occurs and higher familiarity (Kumaran & Maguire, 2007).

The comparative model, on the other hand, suggests that the hippocampus (and specifically, the CA1 region) operates by means of comparing sensory information coming from the entorhinal cortex with information about prior experience (from CA3), coding mismatches between the two sources of input. In this perspective, the hippocampus is not involved directly in coding for novelty (this is handled upstream in the perirhinal cortex) but is primarily concerned with the context of a presented stimulus (Honey et al., 1998; Kumaran & Maguire, 2007). The increased activity in the hippocampus, then, in response to novel stimuli is a reflection of the bonding of stimulus to context in formation of new memory representations (Honey et al., 1998; Kumaran & Maguire, 2007).

A major difference between these two models is that recollection is not called upon or needed to make a familiarity/novelty distinction in the familiarity mechanism but is in the comparator mechanism in order to retrieve stored patterns (Kumaran & Maguire, 2007). This means that associative novelty decisions rely on recall of contextual details of a representation. Consequently, the difference in degree of rating difference between studied and unstudied items in novelty ratings compared to this difference in familiarity ratings may be due to the contribution of recollection processes in making the rating judgment in the case of novelty ratings. It may be the nature of novelty judgments themselves that then is dependent upon some degree of recollection as well as familiarity.

Regarding the second aforementioned question (will repetition priming of the test cue itself change how that cue is experienced in terms of its elicited level of familiarity and novelty?), results of both the second and third experiments suggest that amount of exposure to the test cue itself (through prime duration in Experiment 2 and through overt repetitions in Experiment 3) did not significantly affect the ratings for those cues, neither in the familiarity rating condition, nor the novelty rating condition. However, a trend did emerge in Experiment 3, hinting at an interaction between study status and repetition condition when novelty ratings were used. As I discuss above, this trend may be related to the phenomenon of a higher number of correct guesses in the novelty rating condition, especially in Experiment 3 when the cues were repeated 30 times. The ideas here are that use of the novelty rating scale encourages a retrieval process, whereby any words that share orthographic features with the test cue are generated. This hypothesis is consistent with that put forth above that this paradigm has tapped associative novelty and that this type of novelty requires the input of recollection in that stored patterns must be retrieved for comparison.

An alternative explanation for the amount of the exposure to the cues having no to little effect on the ratings assigned to them could be that the shared orthographic features are not salient enough to produce the types of effects we see with semantic, lexical, and perceptual stimuli (James, 1962; Jacoby & Whitehouse, 1989; Moulin, ; Neely, 1976, 1977a, 1977b). Not only were no habituation-type responses observed following high exposure to the cues, but no facilitative memory effects were observed either after brief presentation of the test cues. Evidence of the uniqueness of this paradigm is demonstrated in the data. For instance, overall, novelty ratings were higher than familiarity ratings, meaning that the scales were used slightly different depending on the rating type. This could be an effect of the cues used, as none were actually studied (and only shared orthographic features with the words that were), they may always feel more novel.

Additionally, the fact that the Jacoby-Whitehouse effect was consistently absent in the RWCR paradigm is possibly a theoretically interesting finding in and of itself. This is because one potential explanation for what drives cue familiarity detection during recall failure (i.e., the RWCR effect) is the fluency with which the cue is processed. It is conceivable that a non-word cue that overlaps in orthographic features with a studied item is processed more fluently than a non-word cue that does not overlap in features with any studied item. If such cue fluency drives the discrimination between cues resembling and not resembling studied words that characterizes RWCR, then one would expect the type of priming of the cue that was performed in the present study to exert an effect. Specifically, the bias that characterizes the Jacoby-Whitehouse effect should emerge. The fact that this bias does not emerge suggests that perhaps the fluency of the test cue is not what drives the RWCR effect. Specifically, because participants are not relying on cue fluency, they discard or ignore the increase in cue fluency that is presumably brought on by the immediate priming of the cue.

A reexamination of the relationship of orthographic cues within existing models of knowledge representation may be needed. A start to this may, in fact, already have been done. A recent study by Tian and Huber (2013) examined semantic satiation through a connectivity reduction perspective. This is a neural network approach that suggests that neural responses to repeated items are reduced to focus on processing of novel items. Magnetoencephalography (MEG) responses were measured and connection efficiency between cortical regions was assessed during a category matching task that involved one category header repeating numerous times while the others presented were each only presented once. They ultimately observed reduced connectivity between the visual word form area, related to processing of orthography, and the left middle temporal lobe, related to lexical and semantic processing, when category headers were repeated. They concluded that semantic satiation is due to connectivity reduction between semantic and orthographic levels. If it is this disconnect that leads to a semantic habituation effect, how might overexposure to orthographic features relate to semantic satiation? Perceptual habituation? Perhaps these problems too can be thought of in a connectivity reduction view and future studies may provide answers as to the configuration and strength of relationships between these factors.

Overall Limitations

The major source of limitations from the two experiments is the uncertainty regarding why there was a failure to find the Jacoby-Whitehouse effect in this paradigm (whereby test items primed with rapid-duration matching primes tend to be judged as more likely to have been studied). It is possible that those types of test item priming effects are simply too weak to detect in this paradigm because those processes are overshadowed by the processes that drive the recognition without cued recall effect. It is also possible that when all of the test items are known to be novel, the attribution from priming is not made. Additionally, because of the complexity of the design, the variable of amount of exposure to the test cue (prime duration in Experiment 1 and 2, and repetition condition in Experiment 3) was kept at two conditions, short duration (or 1 repetition in Experiment 3) and long duration (30 repetitions). With more levels of this variable, it is possible that a different relationship would have been revealed in the data and we would have seen the degree to which exposure can affect subjective judgments. A limitation is that explanations for the failure to find the Jacoby-Whitehouse effect in the RWCR paradigm are only speculative at this time.

The effect observed in the pilot study (Experiment 1) of lower familiarity ratings for test cues paired with mismatched long duration primes compared to those of all other prime conditions was also not observed in either of the following two experiments; in short, that pattern did not replicate and thus was unreliable. While it is possible that unknown differences between the procedures may have led to these very different results between Experiments 1 and 2, it is also possible that the priming pattern found in Experiment 1 was simply a fluke and that is why it did not replicate in Experiment 2.

Future Directions

This set of experiments set the groundwork for future studies with hopes of using novelty ratings. Using novelty ratings to explore amount of exposure to features on various levels of memory representations (perceptual, orthographical, lexical, semantic) may provide insight into how these are all related and as to how novelty specifically is affected. It is also possible that different representation levels tap different types of novelty that might function in different ways than what we have observed in these experiments on the orthographic level.

Attempts to induce fluency and disfluency while using novelty ratings should also be made attempting to reconcile past literatures with the results found here. It is possible that amount of exposure is not the only factor that can influence a feeling of novelty. Perhaps oversaturation to feature or concept representations can be caused by other factors. One possible factor may be depth of processing or quality. Also, what type or types of novelty are working in experiences of jamais vu and deja vu? Follow up experiments should seek to address these issues and inquiries erected by these results should be met with further inspection.

Table 1. Experiment 1 – Mean identification proportion of study targets as a function of Study Status, Prime Match Status, and Prime Duration

	Studied		Unstudied	
Prime Duration	Matching Primes	Mismatched Primes	Matching Primes	Mismatched Primes
50ms	.66 (.16)	.70 (.20)	.23 (.14)	.21 (.13)
1000ms	.65 (.18)	.61 (.22)	.20 (.13)	.20 (.12)

Note. Numbers in parentheses are standard deviations. Identified unstudied items are unstudied targets that were identified from their cues.

Table 2. Experiment 1 – Identified Targets - Mean familiarity ratings for test items as a function of Study Status, Prime Match Status, and Prime Duration

	Studied		Unstudied	
Prime Duration	Matching Primes	Mismatched Primes	Matching Primes	Mismatched Primes
50ms	8.75 (1.08)	8.65 (1.17)	5.66 (1.89)	5.53 (1.97)
1000ms	8.59 (1.15)	8.69 (.97)	5.59 (2.18)	5.64 (2.09)

Note. Numbers in parentheses are standard deviations.

Table 3. Experiment 1 – Unidentified Targets - Mean familiarity ratings for test items as a function of Study Status, Prime Match Status, and Prime Duration

	Studied		Unstudied	
Prime Duration	Matching Primes	Mismatched Primes	Matching Primes	Mismatched Primes
50ms	3.44 (2.01)	3.14 (1.83)	1.98 (1.35)	1.98 (1.40)
1000ms	3.45 (1.99)	1.98 (1.40)	2.07 (1.42)	1.95 (1.24)

Note. Numbers in parentheses are standard deviations.

Table 4. Experiment 2: Identified Targets - Mean familiarity ratings for test items as a function of Study Status, Prime Match Status, and Prime Duration

	Studied		Unstudied	
Prime Duration	Matching Primes	Mismatched Primes	Matching Primes	Mismatched Primes
50ms	8.87 (.86)	8.97 (.81)	5.26 (2.90)	5.26 (2.63)
1000ms	8.77 (.84)	8.71 (1.02)	5.15 (2.48)	5.16 (2.53)

Note. Numbers in parentheses are standard deviations.

Table 5. Experiment 2: Unidentified Targets - Mean familiarity ratings for test items as a function of Study Status, Prime Match Status, and Prime Duration

	Studied		Unstudied	
Prime Duration	Matching Primes	Mismatched Primes	Matching Primes	Mismatched Primes
50ms	3.34 (1.77)	3.73 (2.11)	2.28 (1.35)	2.28 (1.40)
1000ms	3.45 (1.75)	3.50 (1.99)	2.30 (1.40)	2.26 (1.43)

Note. Numbers in parentheses are standard deviations.

Table 6. Experiment 2: Identified Targets - Mean novelty ratings for test items as a function of Study Status, Prime Match Status, and Prime Duration

	Studied		Unstudied	
Prime Duration	Matching Primes	Mismatched Primes	Matching Primes	Mismatched Primes
50ms	2.18 (1.58)	2.24 (1.66)	3.45 (2.15)	3.79 (2.45)
1000ms	2.19 (1.57)	2.33 (1.57)	3.57 (2.00)	3.63 (2.22)

Note. Numbers in parentheses are standard deviations.

Table 7. Experiment 2: Unidentified Targets - Mean novelty ratings for test items as a function of Study Status, Prime Match Status, and Prime Duration

	Studied		Unstudied	
Prime Duration	Matching Primes	Mismatched Primes	Matching Primes	Mismatched Primes
50ms	6.42 (1.91)	6.45 (1.83)	7.00 (1.65)	7.06 (1.68)
1000ms	6.62 (1.70)	6.62 (1.81)	7.00 (1.56)	7.13 (1.70)

Note. Numbers in parentheses are standard deviations.

Table 8. Experiment 2: Mean identification proportion of study targets as a function of Study Status, Prime Match Status, and Prime Duration in the Familiarity Rating condition

	Studied		Unstudied	
Prime Duration	Matching Primes	Mismatched Primes	Matching Primes	Mismatched Primes
50ms	.67 (.17)	.67 (.18)	.20 (.14)	.21 (.15)
1000ms	.68 (.16)	.66 (.17)	.20 (.14)	.20 (.13)

Note. Numbers in parentheses are standard deviations. Identified unstudied items are unstudied targets that were identified from their cues.

Table 9. Experiment 2: Mean identification proportion of study targets as a function of Study Status, Prime Match Status, and Prime Duration in the Novelty Rating condition

	Studied		Unstudied	
Prime Duration	Matching Primes	Mismatched Primes	Matching Primes	Mismatched Primes
50ms	.68 (.16)	.67 (.14)	.26 (.16)	.27 (.19)
1000ms	.67 (.16)	.65 (.16)	.28 (.17)	.26 (.17)

Note. Numbers in parentheses are standard deviations. Identified unstudied items are unstudied targets that were identified from their cues.

Table 10. Experiment 2: Mean number of items across participants that contributed to ratings in each condition

	Familiarity		Novelty	
Identified	Mean	Range	Mean	Range
Studied Match 50ms	16.34	6-28	16.33	7-28
Studied Match 1000ms	16.49	6-27	16.48	7-29
Studied Mismatch 50ms	16.56	5-27	16.41	8-28
Studied Mismatch 1000ms	16.11	8-26	15.87	7-26
Unstudied Match 50ms	5.00	0-13	6.41	0-15
Unstudied Match 1000ms	4.71	0-14	6.83	0-16
Unstudied Mismatch 50ms	5.03	0-13	6.33	0-19
Unstudied Mismatch 1000ms	4.84	0-14	6.41	0-17
Unidentified				
Studied Match 50ms	7.47	0-16	7.47	1-17
Studied Match 1000ms	7.46	1-18	7.53	2-16
Studied Mismatch 50ms	7.49	1-18	7.76	2-16
Studied Mismatch 1000ms	8.08	1-20	8.17	2-16
Unstudied Match 50ms	19.19	11-30	17.80	8-31
Unstudied Match 1000ms	19.34	9-30	17.16	8-29
Unstudied Mismatch 50ms	18.92	7-29	17.51	5-29
Unstudied Mismatch 1000ms	18.96	8-28	17.55	10-27

Table 11. Experiment 3: Mean familiarity ratings for test items as a function of Identification Status, Study Status, and Repetition Condition

	Identified		Unidentified	
Repetitions	Studied	Unstudied	Studied	Unstudied
1x	8.52 (.89)	5.43 (2.03)	2.68 (1.75)	2.21 (1.62)
30x	8.43 (.90)	5.67 (2.03)	2.82 (1.88)	2.34 (1.61)

Note. Numbers in parentheses are standard deviations.

Table 12. Experiment 3: Mean novelty ratings for test items as a function of Identification Status, Study Status, and Repetition Condition

	Identified		Unidentified	
Repetitions	Studied	Unstudied	Studied	Unstudied
1x	4.01 (2.32)	4.74 (2.26)	6.87 (1.91)	7.26 (1.79)
30x	4.18 (2.43)	4.95 (2.50)	7.02 (2.10)	7.13 (2.05)

Note. Numbers in parentheses are standard deviations.

Table 13. Experiment 3: Mean identification proportion of study targets as a function of Rating Type, Study Status, and Repetition Condition

	Familiarity		Novelty	
Repetitions	Studied	Unstudied	Studied	Unstudied
1x	.59 (.14)	.24 (.14)	.54 (.18)	.24 (.15)
30x	.59 (.15)	.26 (.14)	.54 (.17)	.46 (.17)

Note. Numbers in parentheses are standard deviations. Identified unstudied items are unstudied targets that were identified from their cues.

Table 14. Experiment 3: Mean number of items across participants that contributed to ratings in each condition

	Familiarity		Novelty	
Identified	Mean	Range	Mean	Range
Studied Repeated 1x	16.34	6-28	16.33	7-28
Studied Repeated 30x	16.49	6-27	16.48	7-29
Unstudied Repeated 1x	5.00	0-13	6.41	0-15
Unstudied Repeated 30x	4.71	0-14	6.83	0-16
Unidentified				
Studied Repeated 1x	19.39	9-37	22.34	9-44
Studied Repeated 30x	19.33	8-31	21.60	10-46
Unstudied Repeated 1x	36.33	17-49	35.63	22-48
Unstudied Repeated 30x	34.89	18-48	38.09	24-53

Table 15. Mean number of identification responses made across Rating Type in Experiments 2 and 3

Experiment 2		Experiment 3	
Familiarity	Novelty	Familiarity	Novelty
101.18 (23.59)	109.74 (30.82)	101.26 (30.51)	90.06 (34.55)

Note. Numbers in parentheses are standard deviations.

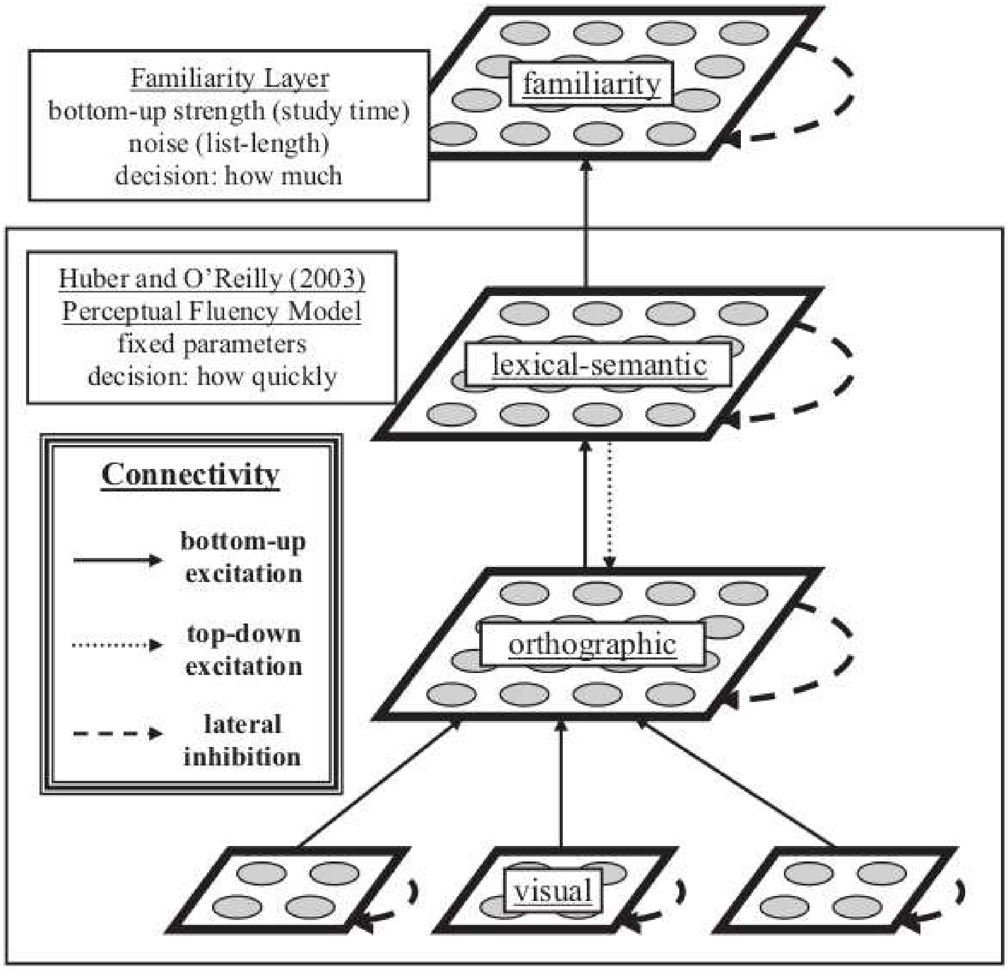

Figure 1. Hierarchy of the Fluency-Disfluency Model (Huber, 2008)

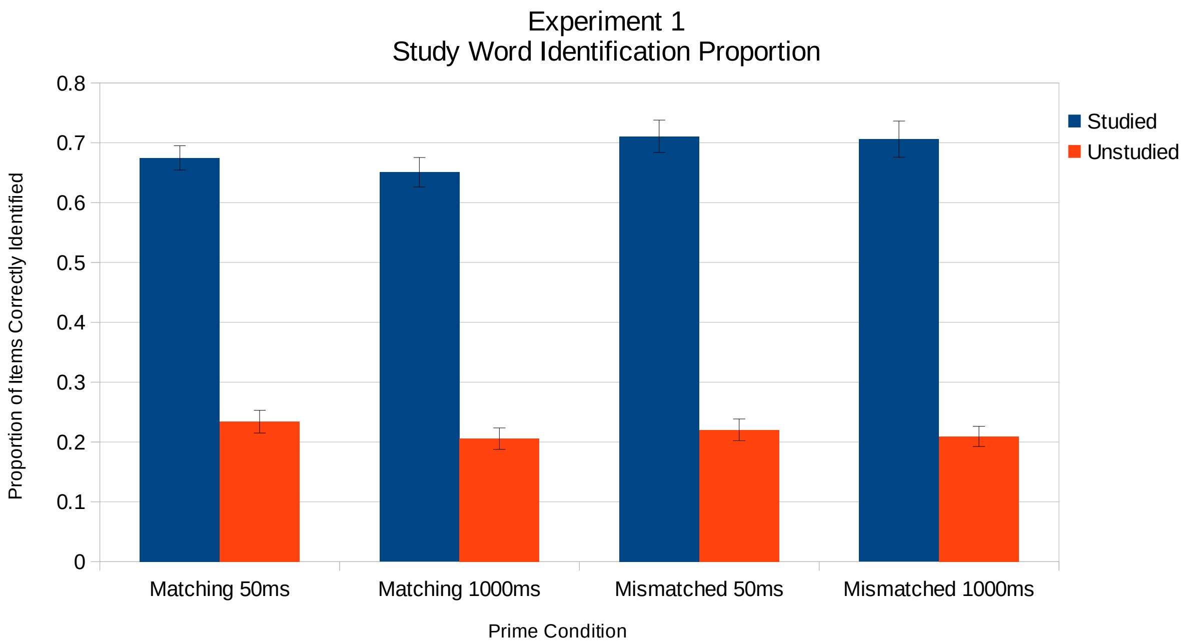

Figure 2. Experiment 1 – Study word identification proportions across all conditions of Study Status, Prime Duration, and Prime Match Status.

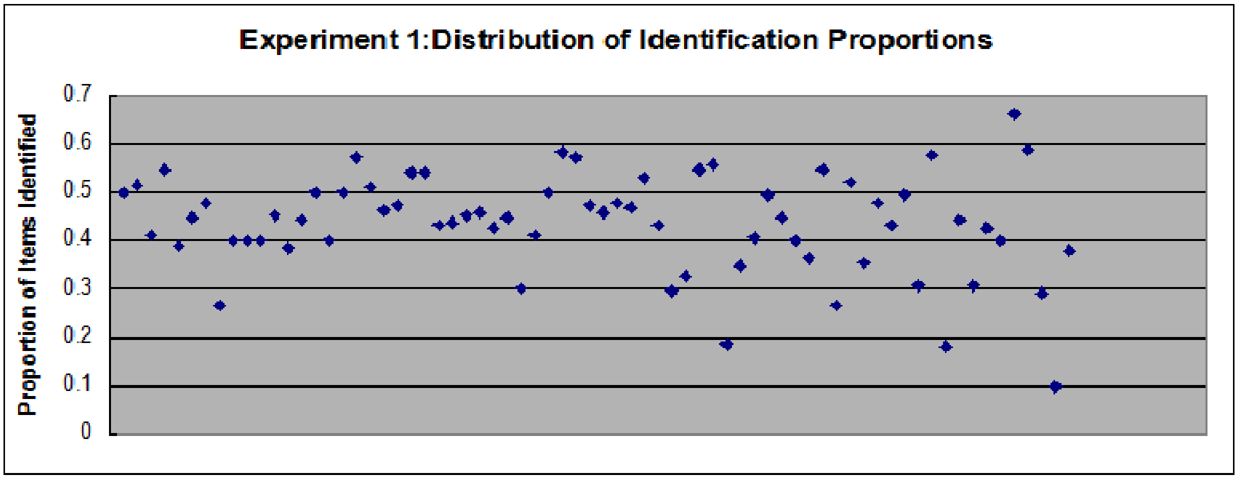

Figure 3. Distribution of mean identification proportions across subjects.

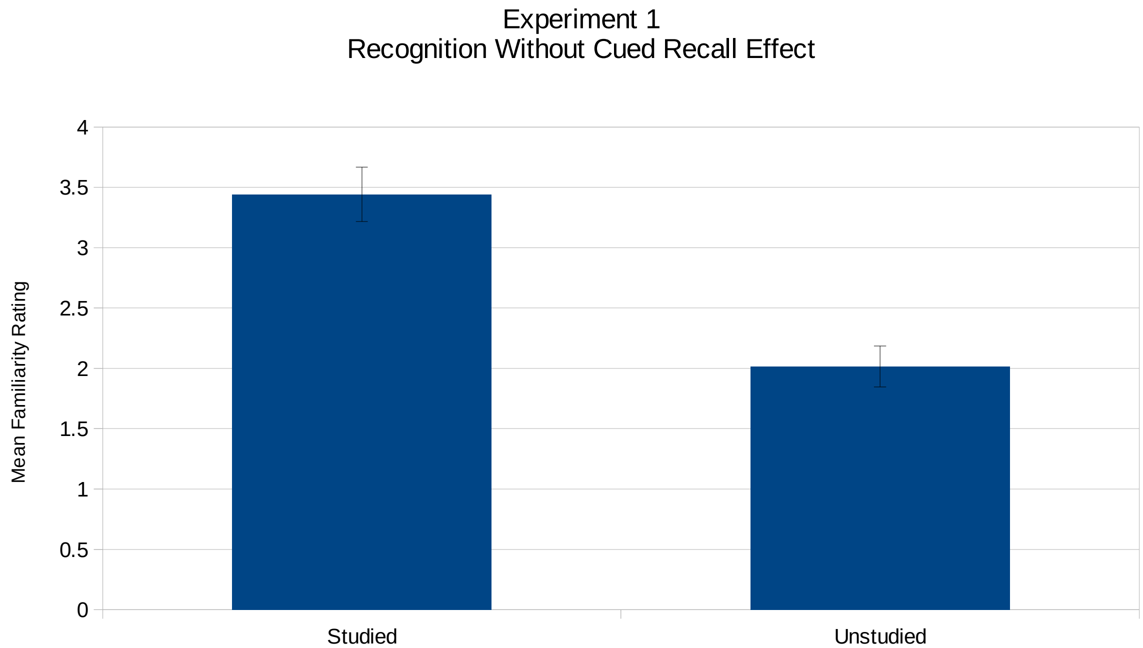

Figure 4. Experiment 1 - Familiarity ratings for test cues among items for which a similar study item was not identified, showing the RWCR effect of higher familiarity ratings for items that had a graphemically similar word presented at study.

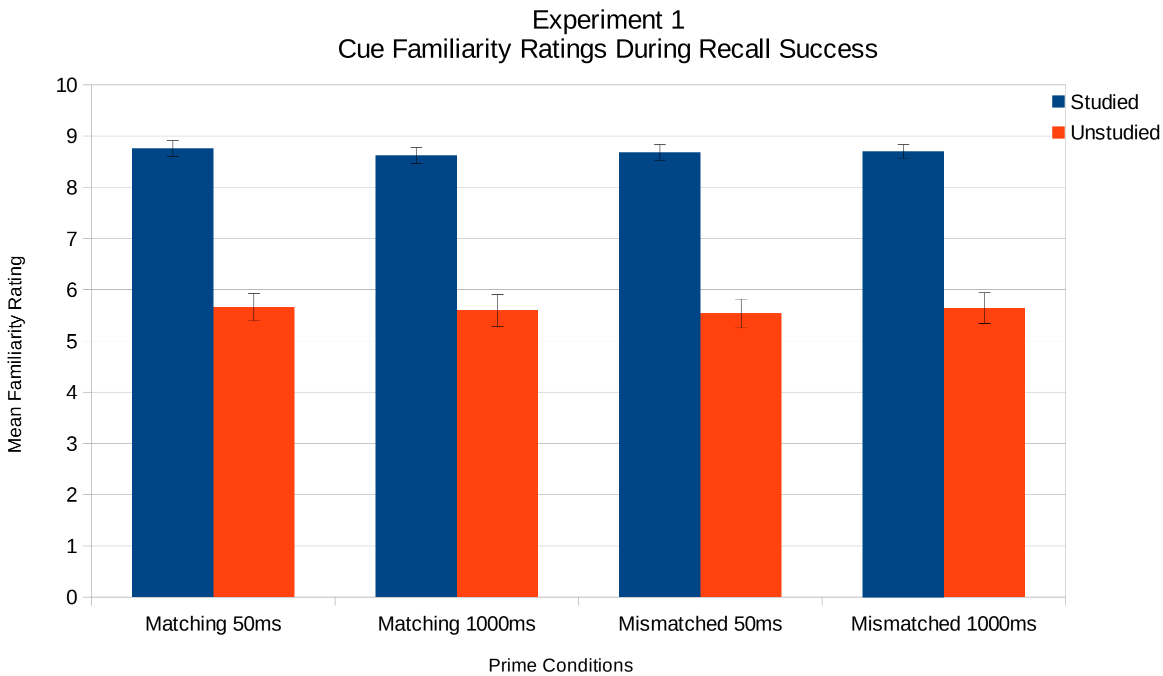

Figure 5. Experiment 1 - Familiarity ratings for test cues for which corresponding study items were successfully recalled.

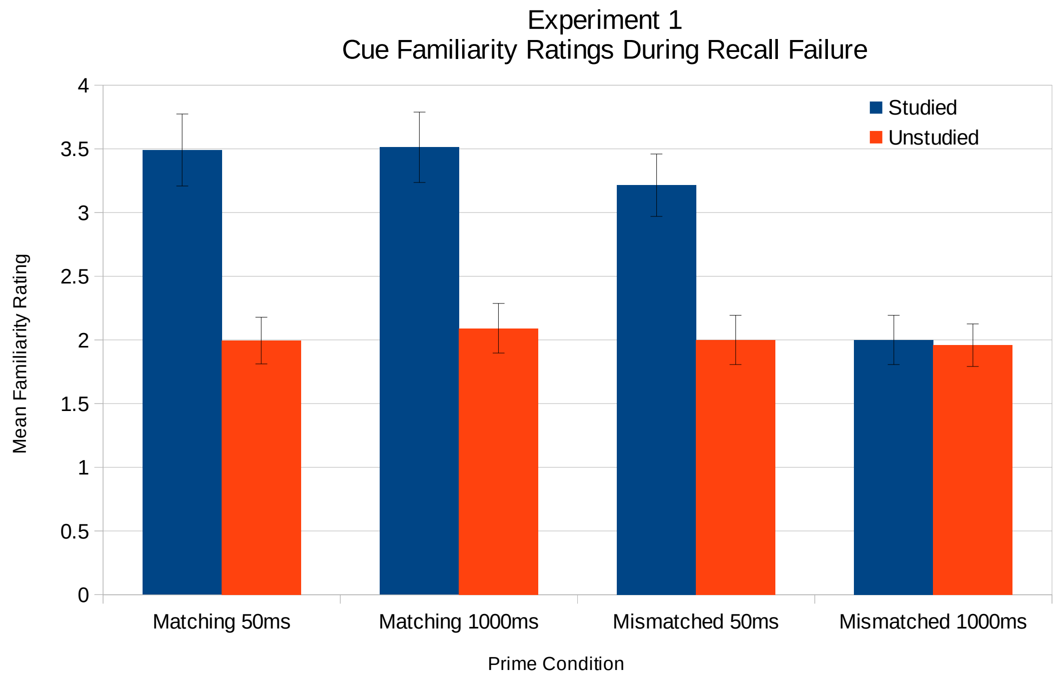

Figure 6. Experiment 1 - Familiarity ratings for test cues for which corresponding study items failed to be successfully recalled.

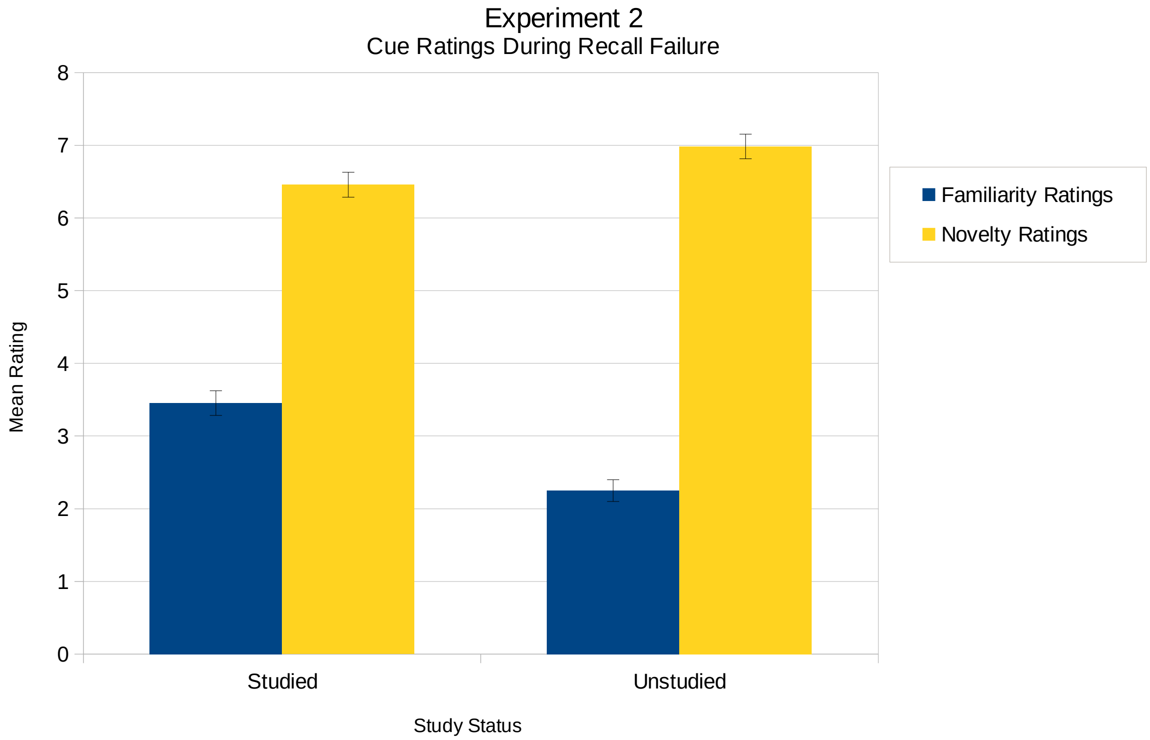

Figure 7. Experiment 2 - Familiarity ratings for test cues among items for which a similar study item was not identified, showing the RWCR effect of higher familiarity ratings for items that had a graphemically similar word presented at study. Novelty ratings show a reversed RWCR effect of lower novelty ratings for items that had a similar word presented at study.

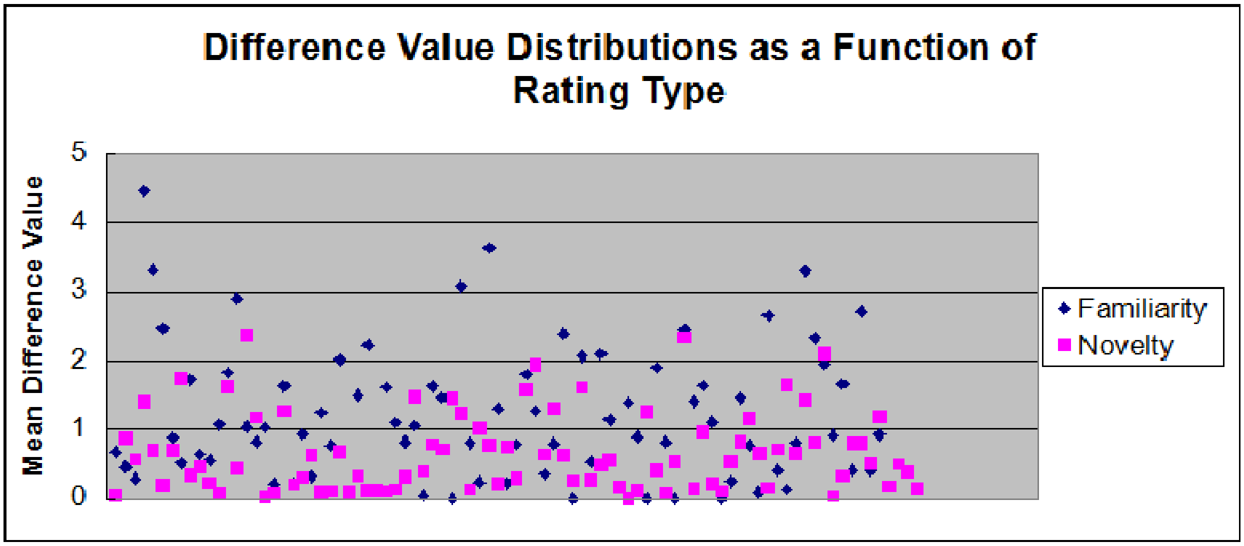

Figure 8. Experiment 2 - Mean distribution of difference values (ratings for test cues resembling studied items - ratings for test cues that did not resemble studied items) across rating type.

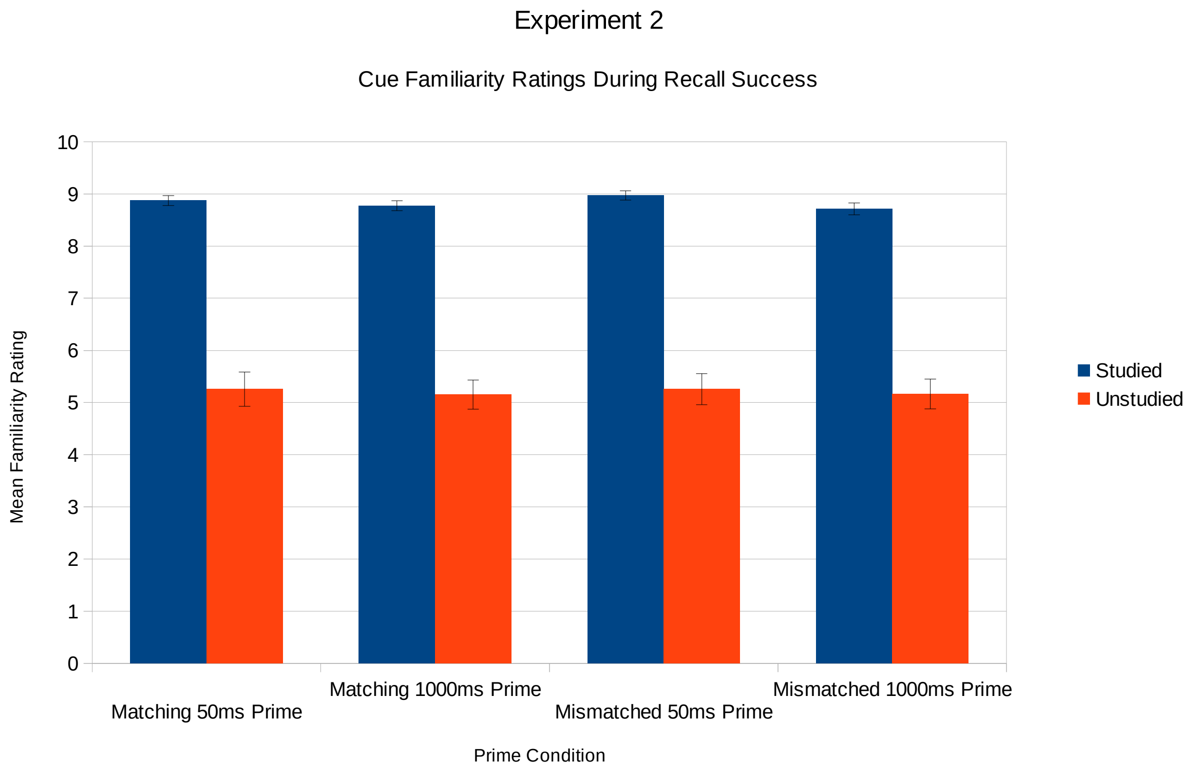

Figure 9. Experiment 2 - Familiarity ratings for test cues for which corresponding study items were successfully recalled.

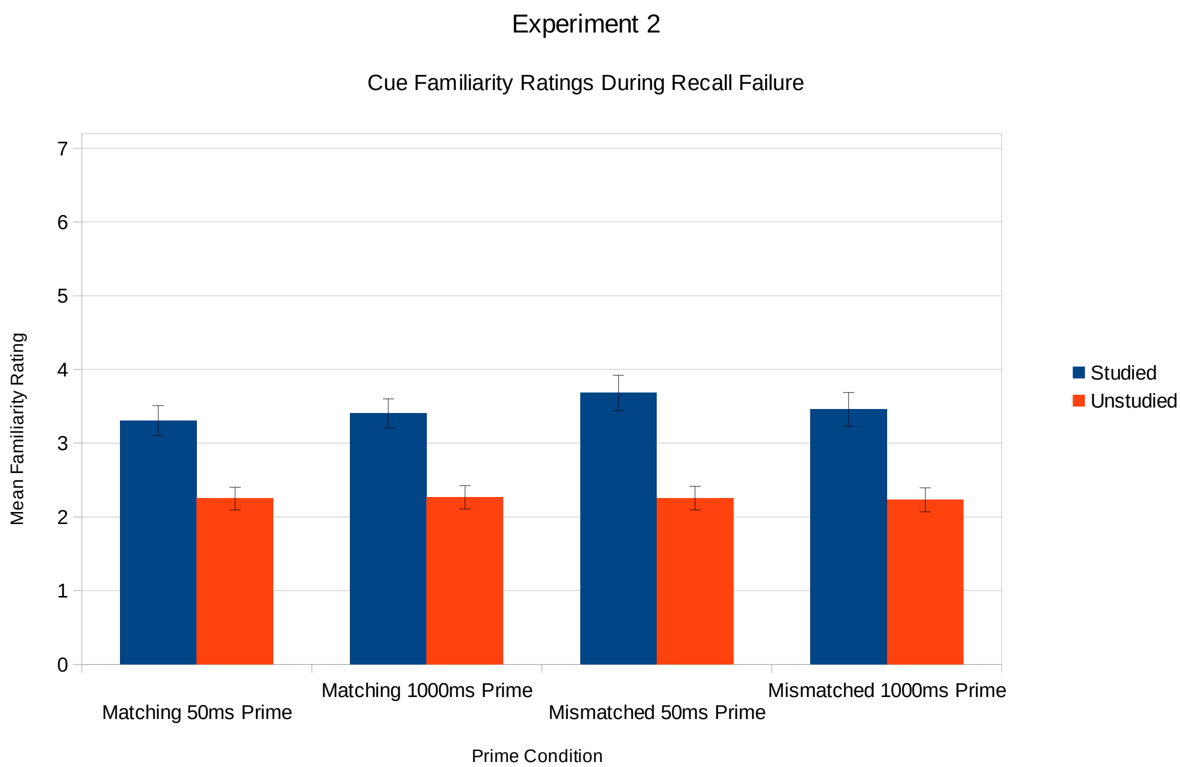

Figure 10. Experiment 2 - Familiarity ratings for test cues for which corresponding study items failed to be successfully recalled.

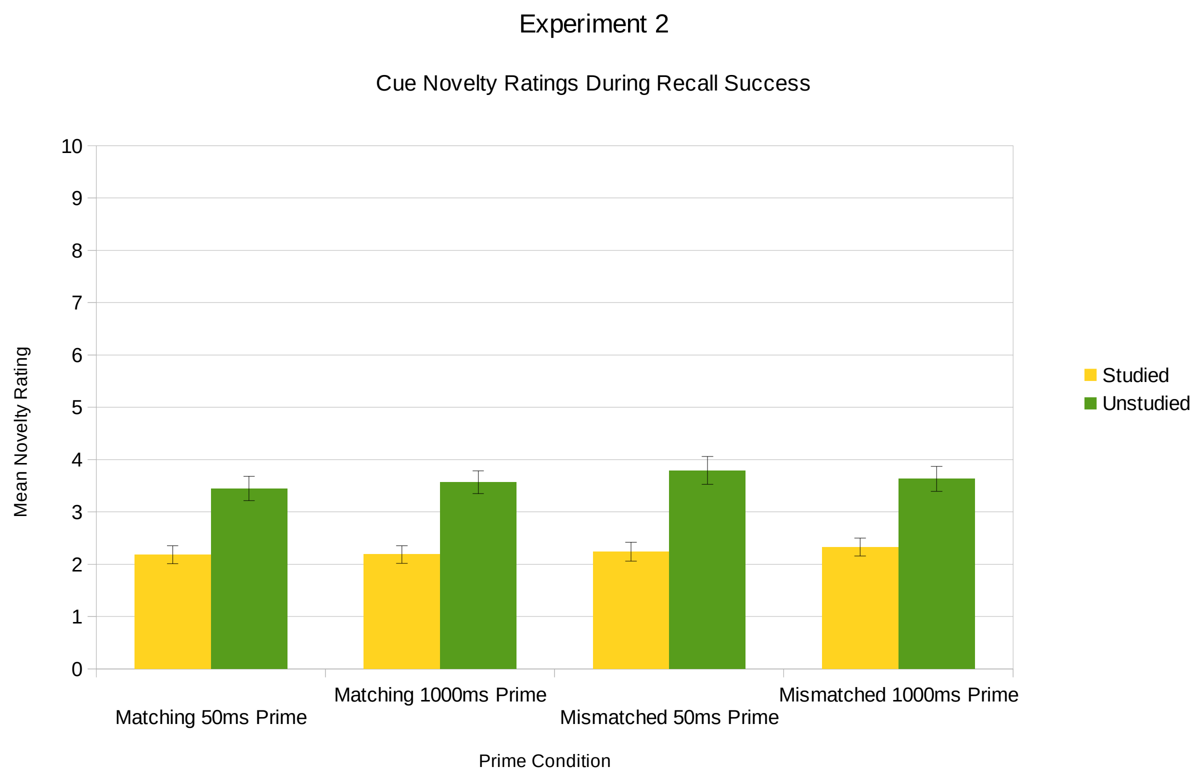

Figure 11. Experiment 2 - Novelty ratings for test cues for which corresponding study items were successfully recalled.

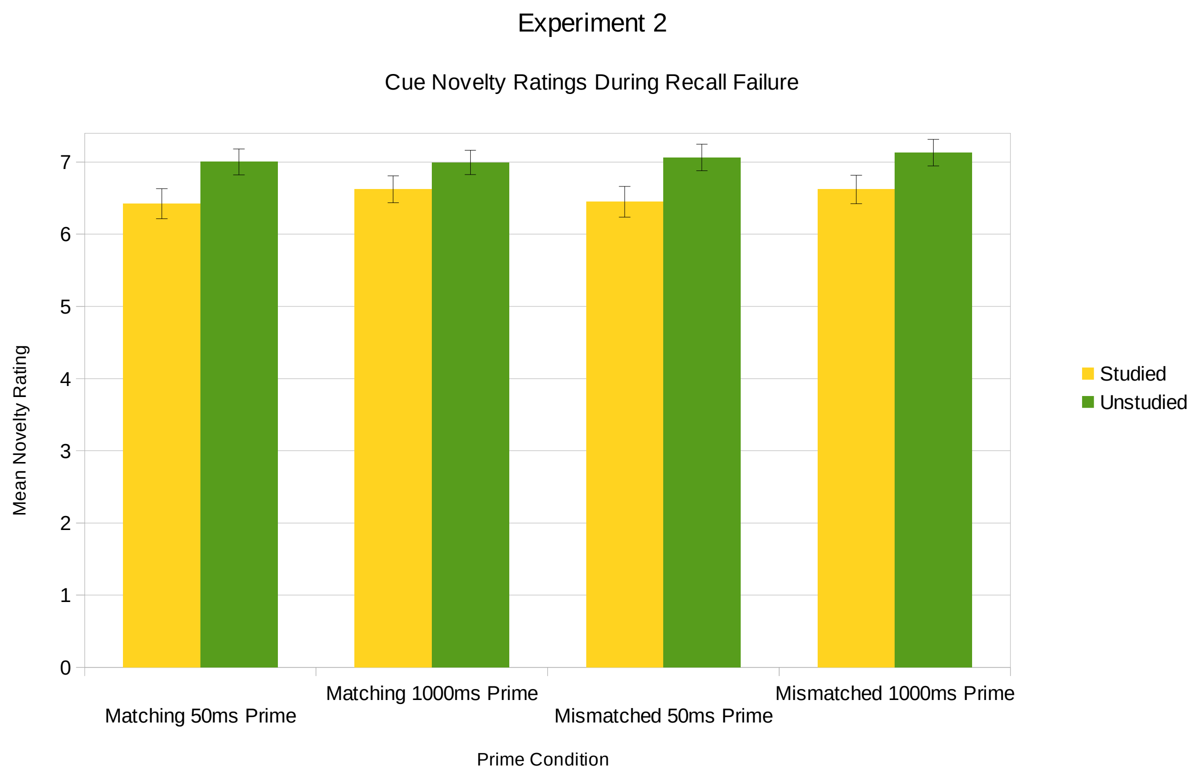

Figure 12. Experiment 2 - Novelty ratings for test cues for which corresponding study items failed to be successfully recalled.

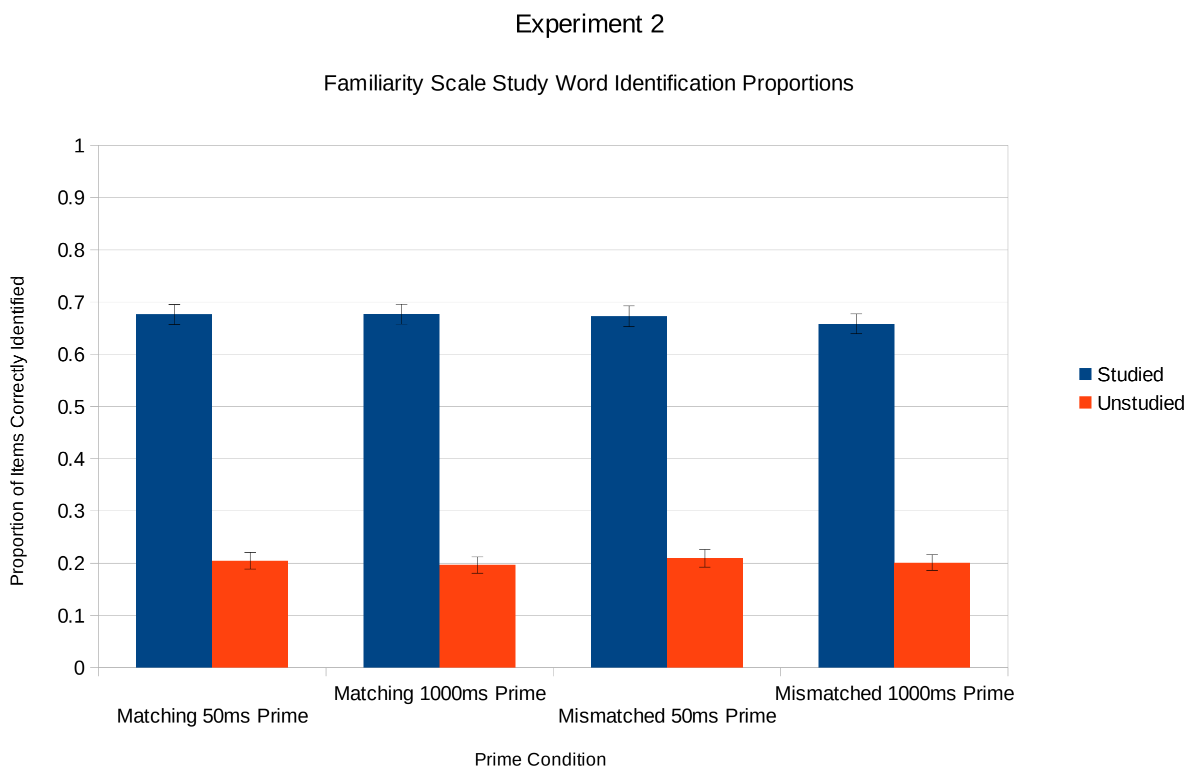

Figure 13. Experiment 2 – Study word identification proportions across all conditions of Study Status, Prime Duration, and Prime Match Status in the Familiarity Rating condition.

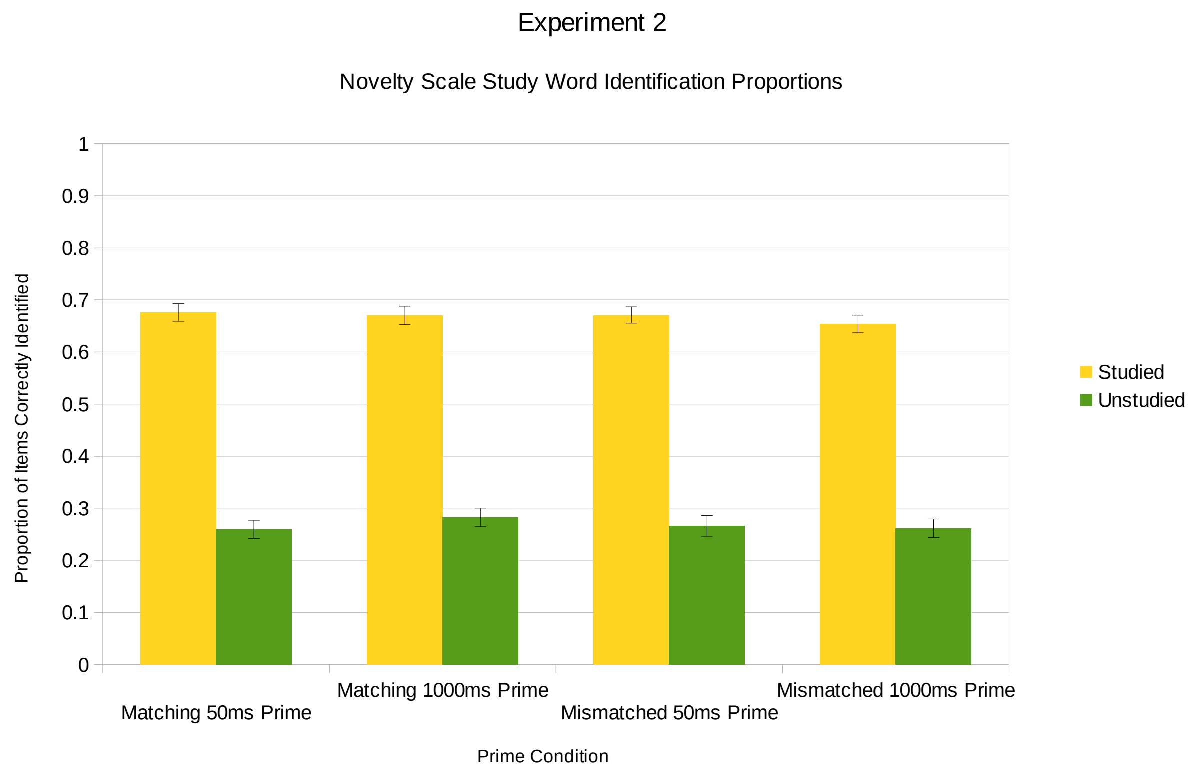

Figure 14. Experiment 2 – Study word identification proportions across all conditions of Study Status, Prime Duration, and Prime Match Status in the Novelty Rating condition.

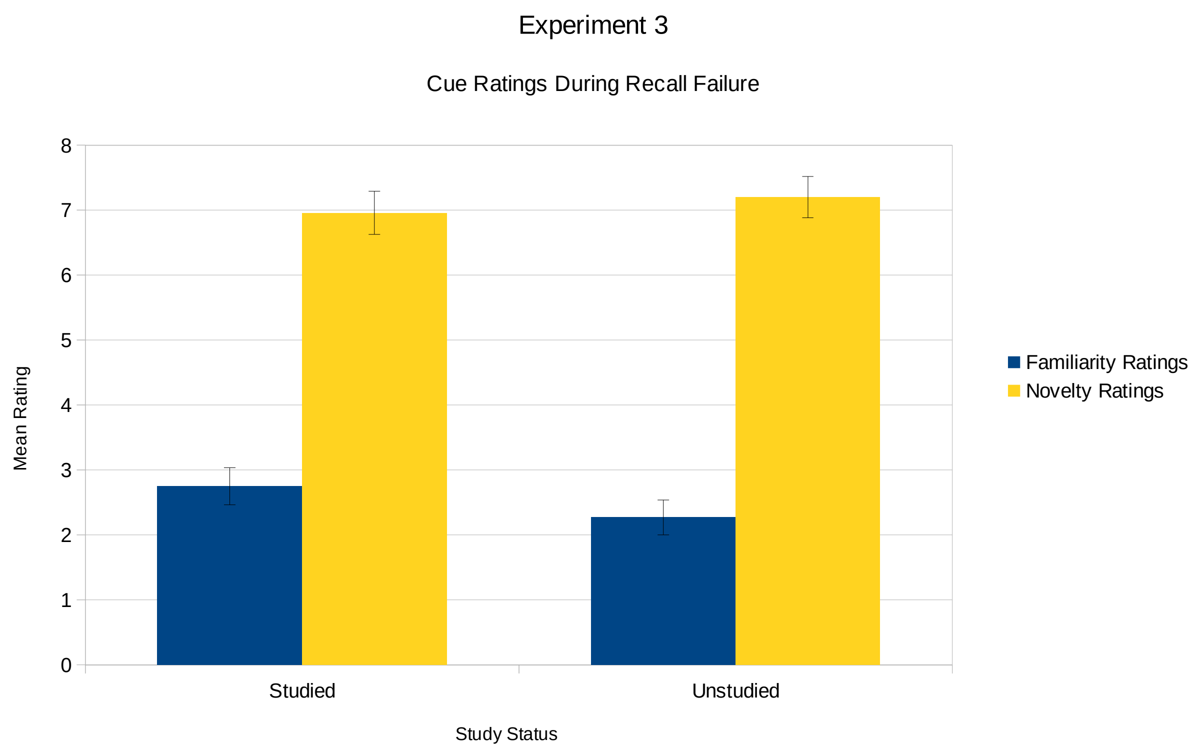

Figure 15. Experiment 3 - Familiarity ratings for test cues among items for which a similar study item was not identified, showing the RWCR effect of higher familiarity ratings for items that had a graphemically similar word presented at study. Novelty ratings show lower novelty ratings for items that had a similar word presented at study.

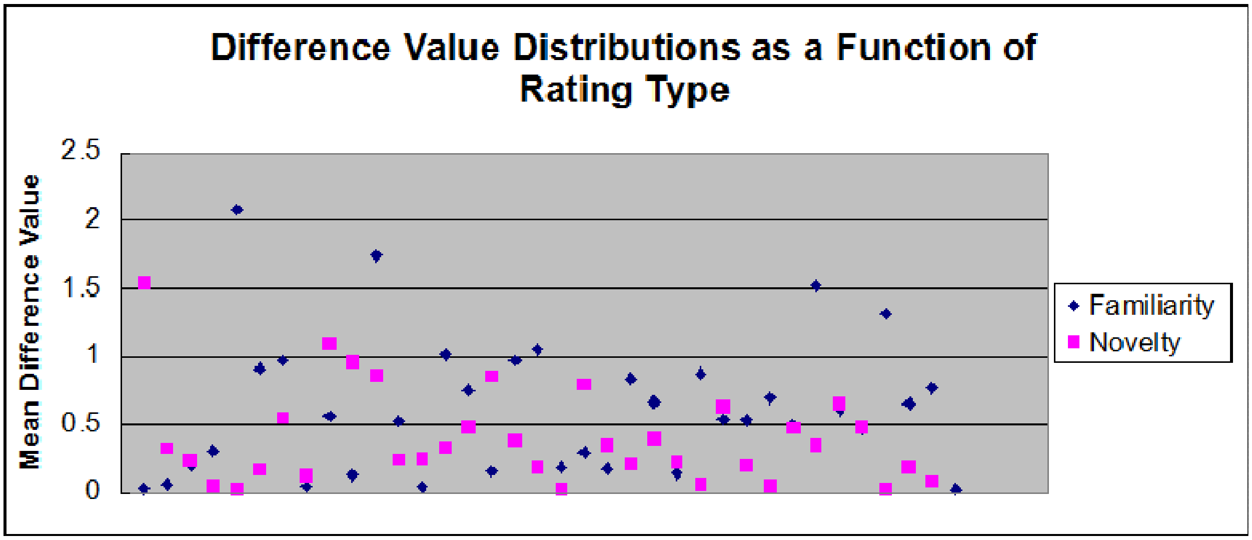

Figure 16. Experiment 3 - Mean distribution of difference values across rating type.

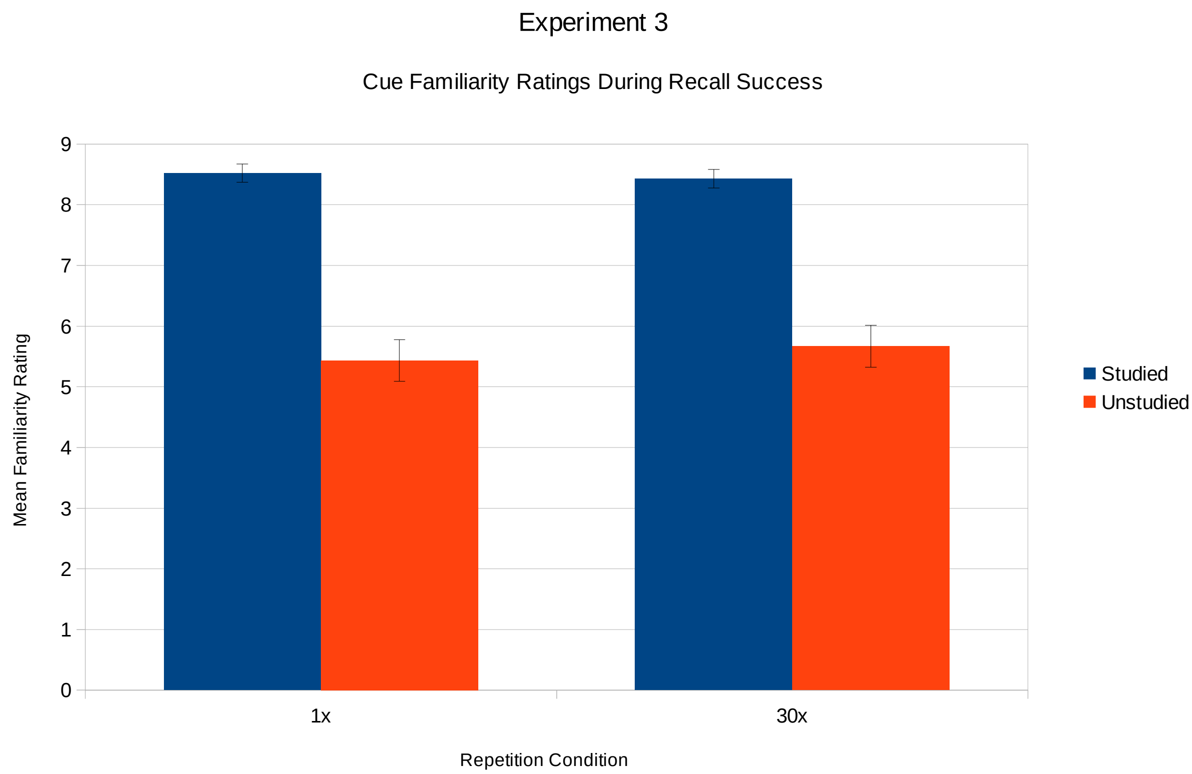

Figure 17. Experiment 3 - Familiarity ratings for test cues for which corresponding study items were successfully recalled.

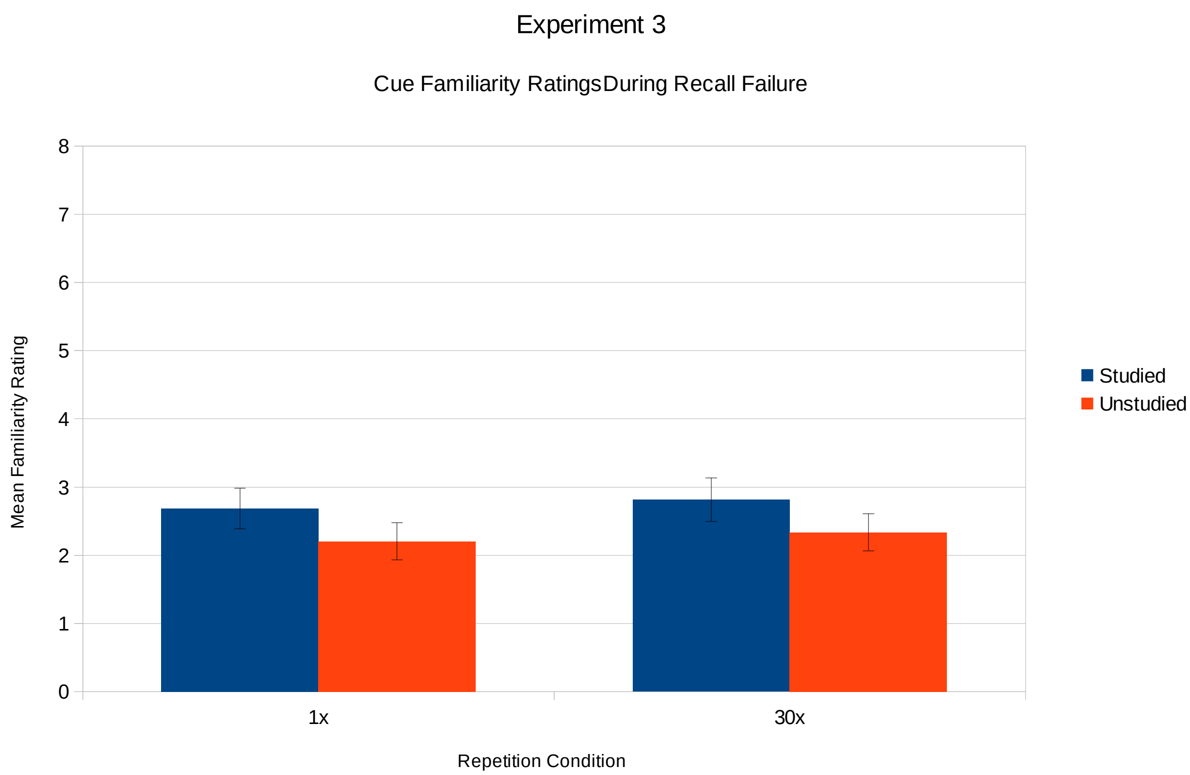

Figure 18. Experiment 3 - Familiarity ratings for test cues for which corresponding study items failed to be successfully recalled.

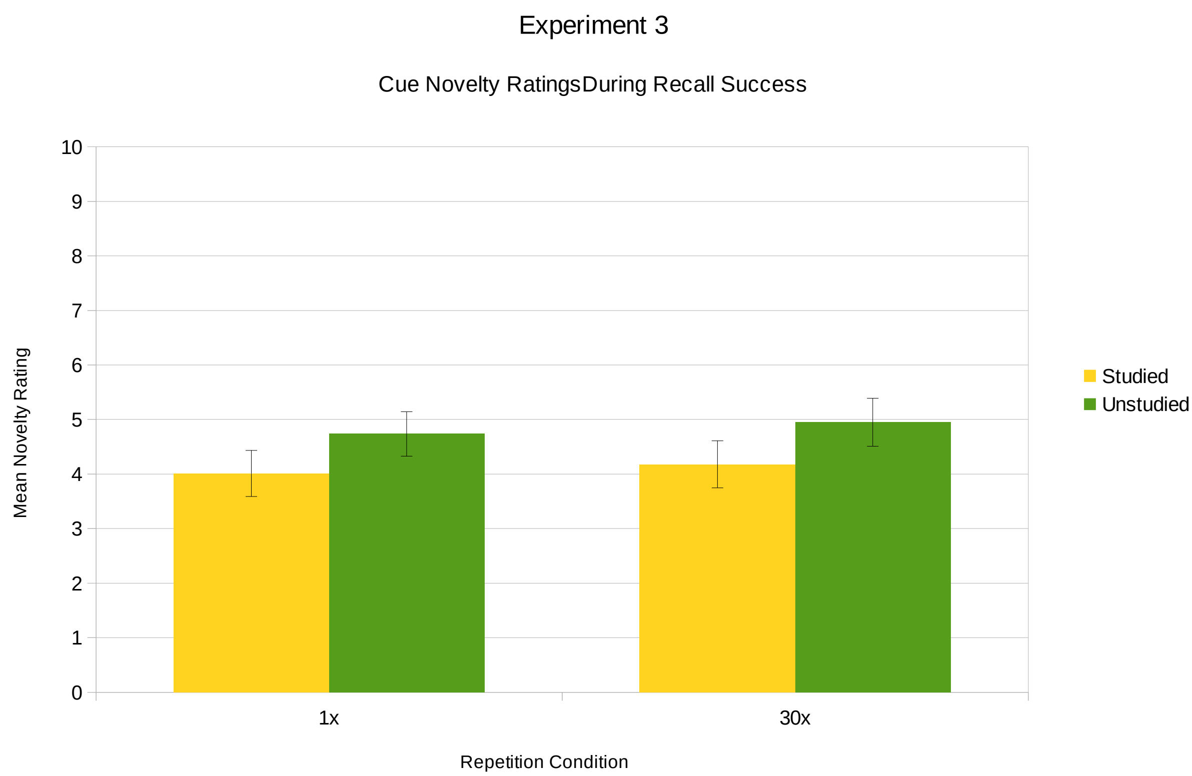

Figure 19. Experiment 3 - Novelty ratings for test cues for which corresponding study items were successfully recalled.

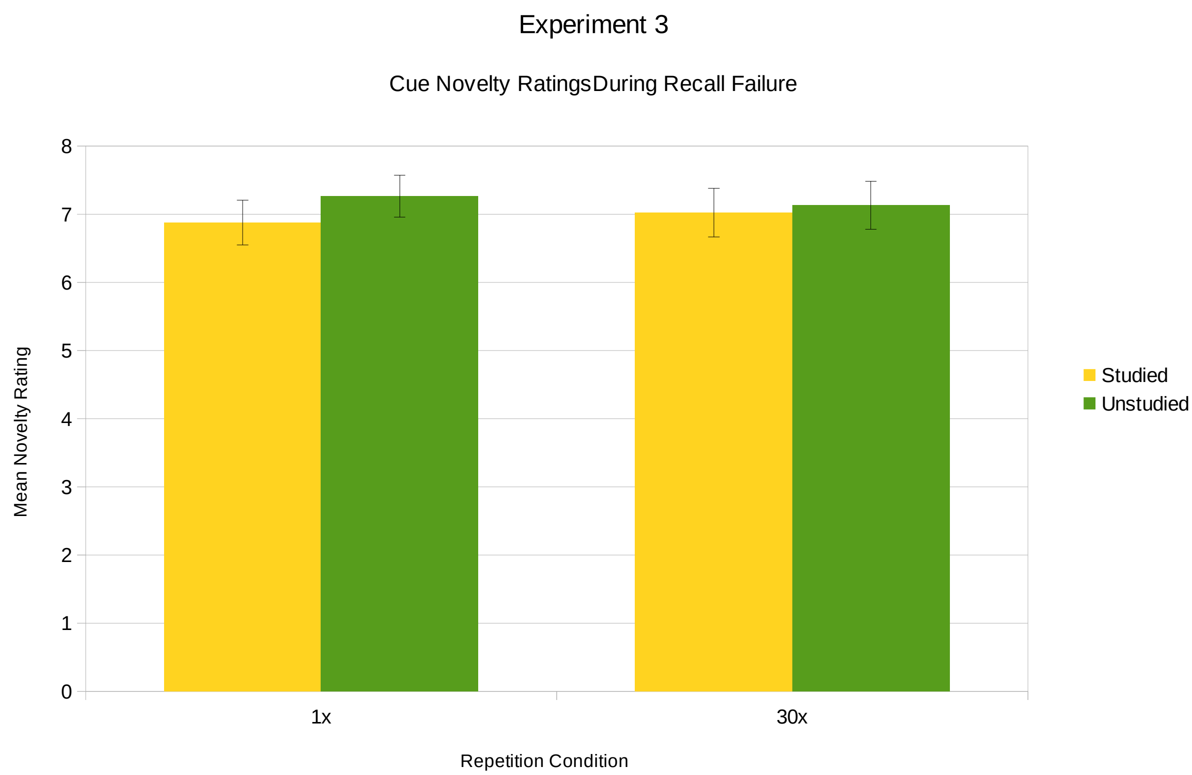

Figure 20. Experiment 3 - Novelty ratings for test cues for which corresponding study items failed to be successfully recalled.

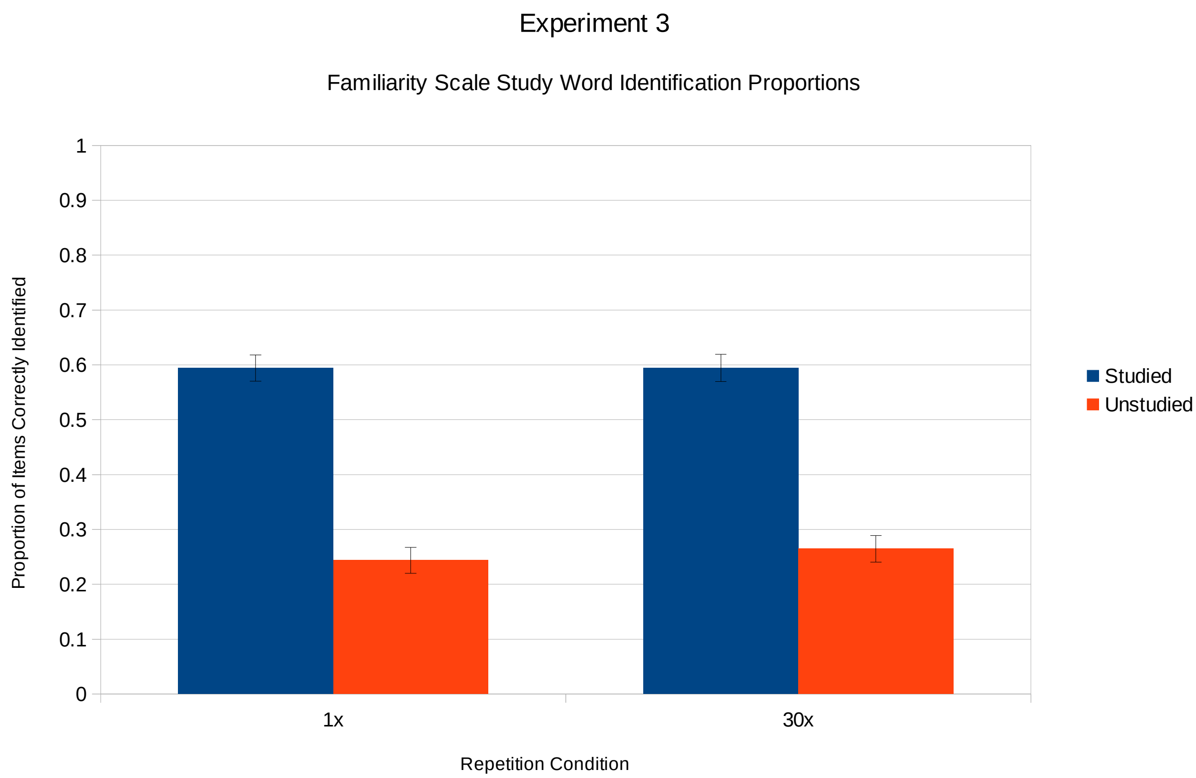

Figure 21. Experiment 3 – Study word identification proportions across all conditions of Study Status and Repetition Condition in the Familiarity Rating condition.

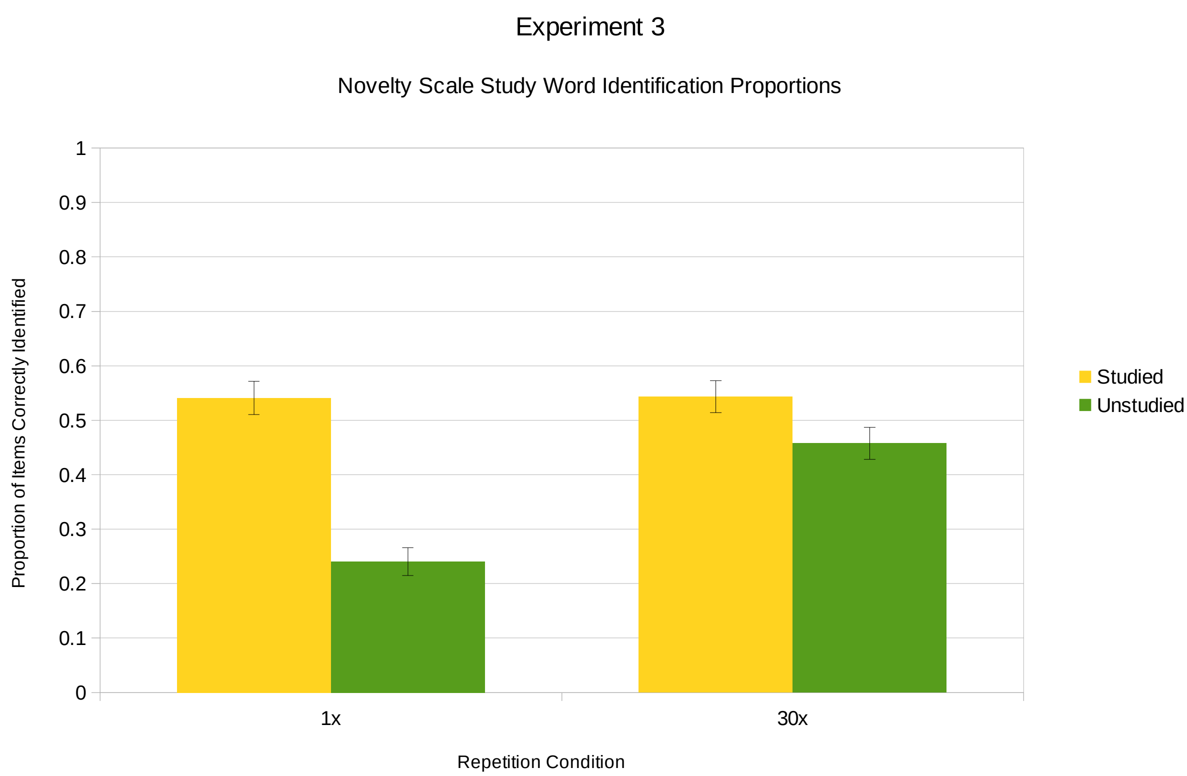

Figure 22. Experiment 3 – Study word identification proportions across all conditions of Study Status, and Repetition Condition in the Novelty Rating condition.

REFERENCES

Althoff, R. R., & Cohen, N. J. (1999). Eye-movement-based memory effect: A reprocessing effect in face perception. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 25*(4), 997-1010.

Brown, A. S. (2004). The Deja Vu Experience: Essays in Cognitive Psychology. Psychology Press: New York.

Brown, A. S. & Marsh, E. J. (2010). Digging Into De´ja` Vu: Recent Research on Possible Mechanisms. In Brian H. Ross editor. The Psychology of Learning and Motivation, Vol. 53, Burlington: Academic Press, 2010, pp. 33-62.

Bunzeck, N., Doeller, C. F., Fuentemilla, L., Dolan, R. J., & Duzel, E. (2009). Reward motivation accelerates the onset of neural novelty signals in humans to 85 milliseconds. *Current Biology, 19*(15), 1294-1300.

Buzsaki, G. (2006). Rhythms of the Brain. Oxford University Press, USA.

Cleary, A. M. (2008). Recognition memory, familiarity, and 'Deja vu' experiences. *Current Directions in Psychological Science, 17*(5), 353-357.

Cleary, A. (2004). Orthography, phonology, and meaning: Word features that give rise to feelings of familiarity in recognition. *Psychonomic Bulletin & Review, 11*(3), 446-451.

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

Cleary, A. M., Brown, A. S., Sawyer , B. D., Nomi, J. S., Ajoku, A. C., & Ryals, A. J. (2012). Familiarity from the configuration of objects in 3-dimensional space and its relation to déjà vu: A virtual reality investigation. C*onsciousness and Cognition,* Received 7 July 2011.

Diana, R. A. & Reder, L. M. (2006). The low-frequency encoding disadvantage: Word frequency affects processing demands. *Journal of Experimental Psychology: Learning, Memory, & Cognition, 32*(4), 805-815.

Duzel, E., Habib, R., Rotte, M., Guderian, S., Tulving, E., & Heinze, H-J. (2003). Human hippocampal and parahippocampal activity during visual associative recognition memory for spatial and nonspatial stimulus configurations. *Journal of Neuroscience, 23*(28), 9439-9444.

Ellis, H. D., Young, A. W., Quayle, A. H., & de Pauw, K. W. (1997). Reduced autonomic responses to faces in Capgras delusion. *Proceedings: Biological Sciences, 264*(1384), 1085-1092.

Gallo, D. A., Perlmutter, D. H., Moore, C. D., and Schacter, D. L. (2008). Distinctive encoding reduces the Jacoby-Whitehouse illusion. *Memory & Cognition, 36*(2), 461-466.

Glenberg, A. M. (1997). What memory is for. *Behavioral and Brain Sciences, 20,* 1-55.

Hannula, D. E., Althoff, R. R., Warren, D. E., Riggs, L., Cohen, N. J., & Ryan, J. D. (2010). Worth a glance: using eye movements to investigate the cognitive neuroscience of memory. *Frontiers in Human Neuroscience, 4* (166), 1-16.

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

Honey, R. C., Watt, A., Good, M. (1998). Hippocampal lesions disrupt an associative mismatch process. *Journal of Neuroscience, 18*(6), 2226-22230.

Huber, D. E. (2008). Immediate priming and cognitive aftereffects. *Journal of Experimental Psychology: General, 2*, 324 –347.

Huber, D. E., Clark, T. F., Curran, T., & Winkielman, P. (2008). Effects of repetition priming on recognition memory: Testing a perceptual fluency-disfluency model. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 34*(6), 1305-1324.

Hunt, R. R. (1995). The subtlety of distinctiveness: What von Restorff really did. P*sychonomic Bulletin & Review, 2*(1), 105-112.

Jacoby, L. L. (1999). Deceiving the elderly: effects of accessibility bias in cued-recall performance. *Cognitive Neuropsychology, 16*, 417–36.

Jacoby, L. L., Toth, J. P. & Yonelinas, A. P. (1993). Separating conscious and unconscious influences of memory: Measuring recollection. *Journal of Experimental Psychology: General , 122*(2), 139-154.

Jacoby, L. L., & Whitehouse, K. (1989). An illusion of memory: False recognition influenced by unconscious perception. *Journal of Experimental Psychology: General, 118*, 126 –135.

James, J. L. (April 1962). “Cognitive Aspects of Behavior: Some Experiments on the Phenomenon of Semantic Satiation.” A thesis presented to Department of Psychology, McGill University, Montreal.

Kakade, S., & Dayan, P. (2002). Dopamine: generalization and bonuses . *Neural Networks, 15*, 549–559.

Koriat, A. (2000). The feeling of knowing: Some metatheoretical implications for consciousness and control. *Consciousness and Cognition, 9*, 149-171.

Koriat, A., & Leiblich, I. (1977). A study of memory pointers. *Acta Psychologia, 41*, 151-164.

Kim, K., Yi, D-J., Raye, C. L., & Johnson, M. K. (2012). Negative effects of item repetition on source memory. *Memory and Cognition*, published online 13 March. DOI 10.3758/s13421-012-0196-2

Kumaran, D., & Maguire, E. A. (2007). Which computational mechanisms operate in the hippocampus during novelty detection? *Hippocampus, 17*, 735-748.

Kurilla, B. P., & Westerman, D. L. (2008). Processing fluency affects subjective claims of recollection. *Memory & Cognition, 36*(1), 82-92.

Lubow, R. E., & Moore, A. U. (1959). Latent inhibition: The effect of non-reinforced preexposure to the conditional stimulus. *Journal of Comparative & Physiological Psychology, 52,* 415-419.

Mandler, G. (2008). Familiarity breeds attempts: A critical review of dual-process theories of recognition. *Perspectives on Psychological Science, 3*, 390-399.

Mundy, M. E., Honey, R. C., & Dwyer, D. M. (2007). Simultaneous presentation of similar stimuli produces perceptual learning in human picture processing. *Journal of Experimental Psychology: Animal Behavior Processes, 33,* 124- 138.

Neely, J. H. (1976). Semantic priming and retrieval from lexical memory: Evidence for facilitory and inhibitory processes. *Memory and Cognition, 4*(5), 648-652.

Neely, J. H. (1977a). The effects of visual and verbal satiation on a lexical decision task. *American Journal of Psychology, 90,* 447- 459.

Neely, J. H. (1977b). Semantic priming and retrieval from lexical memory: Roles of inhibitionless spreading activation and limited capacity attention. *Journal of Experimental Psychology: General, 106*(3), 226-254.

O'Connor, A. R., Level, C., & Moulin, C. J. (2010). Novel insights into false recollection: A model of deja vecu. *Cognitive Neuropsychiatry, 15*, 118-144.

O'Keefe, J. & Nadel, L. (1978). The Hippocampus as a Cognitive Map. Oxford: Oxford University Press.

Ramachandran, V. S. (2004). A Brief Tour of Human Consciousness. Pi Press: New York.

Ranganath, C., & Rainer, G. (2003). Neural mechanisms for detecting and remembering novel events. *Nature Reviews: Neuroscience, 4*, 193-202.

Read, J. D., Vokey, J. R., & Davidson, M. (1991, November). Knowing who's new: The phenomenon of jamais vu. Paper presented at the 32nd annual meeting of the Psychonomic Society, San Francisco.

Rinkus, G. J. (2010). A cortical sparse distributed coding model using mini- and macrocolumn-scale functionality. *Frontiers in Neuroanatomy, 4*(17), 1-13.

Ryan, J. D., Althoff, R. R., Whitlow, S., & Cohen, N. J. (2000). Amnesia is a deficit in relational memory. *Psychological Science, 11*(6), 454-461.

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, 66*, 747-762.

Share, D. L. (2004). Orthographic learning at a glance: On the time course and developmental onset of self-teaching. *Journal of Experimental Child Psychology, 87*, 267-298.

Skatssoon, Judy. (19 July 2006). “Is it you or jamais vu?” ABC Science Online. Accessed by: http://www.abc.net.au/science/news/health/HealthRepublish_1689668.htm on 2/14/13.

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. Lawrence Erlbaum: New Jersey.

Smith, L. & Klein, R. (1990). Evidence for semantic satiation: Repeating a category slows subsequent semantic processing . *Journal of Experimental Psychology: Learning, Memory, and Cognition, 16*(5), 852-861.

Stanley, E. M., Wilson, M. A. & Fadel, J. R. (2012). Hippocampal Neurotransmitter efflux during one-trial novel object recognition in rats. *Neuroscience Letters, 511*, 38-42.

Stern, C. E., Sherman, S. J., Kirchoff, B. A., & Hasselmo, M. E. (2001). Medial temporal and prefrontal contributions to working memory tasks with novel and familiar stimuli. *Hippocampus, 11*, 337-346.

Tian, X., & Huber, D. E. (2013). Playing “Duck Duck Goose” with neurons: Change detection through connectivity reduction. *Psychological Science, 24*(6), 819-827.

Topolinski, S. (2012). The sensorimotor contributions to implicit memory, familiarity, and recolloection. *Journal of Experimental Psychology: General, 141*(2), 260-281.

Tulving, E., & Kroll, N. (1995). Novelty assessment in the brain and long-term memory encoding. *Psychonomic Bulletin & Review, 2*, 387-390.

Viskontas, I. V., Knowlton, B. J., Steinmetz, P. N., & Fried, I. (2006). Differences in mnemonic processing by neurons in the human hippocampus and parahippocampal regions. *Journal of Cognitive Neuroscience, 18*(10), 1654-1662.

Von Restorff, H. (1933). Über die Wirkung von Bereichsbildungen im Spurenfeld (The effects of field formation in the trace field). *Psychological Research 18*(1), 299–342. doi:10.1007/BF02409636.

Wang, T., & Mitchell, C. J. (2011). Attention and relative novelty in human perceptual learning . *Journal of Experimental Psychology: Animal Behavior Processes* , *37*(4), 436–445.

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