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Reading Emotion Words in Sentences: Exploring Interactions Between Valence and Arousal

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Abstract

Emotional information is treated differently than any other type of information and has a powerful impact on many cognitive processes, particularly attention. As there are currently two opposing theories about how emotion influences attention, the aim of this study was to test both categorical negativity theory and the arousal hypothesis simultaneously. Categorical negativity theory suggests that the valence of a word (how positive or negative it is) is what truly influences how emotional information receives attention, while the arousal hypothesis posits that the arousal level of a word (how stimulating or salient it is) determines the amount of attention it receives. In the current work, we used the rapid serial visual presentation (RSVP) task to investigate interactions between valence and arousal. The valence and arousal levels of positive and negative emotion words were manipulated within the context of full-sentence reading. Analyses revealed that positive words appeared to benefit from repetition, while negative and neutral word recall was decreased by repetition. Additionally, there was an interaction of valence and arousal, such that high and low arousal values impacted positive word recall differently, but did not have any effect on the recall of negative words. Overall, the results suggest an emotional memory enhancement effect, exclusive to positive emotion words. These findings indicate the need for a new theory to accommodate evidence that both valence and arousal play a role in the attentional capture of emotion words.

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Emotion is heavily involved in human cognition. It plays a large role in several cognitive processes like memory, decision making, and attention. In particular, emotion can modulate and influence several attentional processes. When multiple stimuli are competing for a limited amount of attention, those with emotional connotations receive more attentional resources (Yiend, 2010). This bias towards emotional information allows us to detect emotional events and prepare for them with speed and efficiency (Pourtois, Schettino, & Vuilleumier, 2013). While the majority of the research in this field has focused on our detection of negatively valenced stimuli, there is a growing body of work supporting the idea that we also have an attentional bias for positively valenced, rewarding stimuli (see Pool, Brosch, Delplanque, & Sander, 2016).

Emotion is most commonly classified along a two-dimensional model based on valence and arousal (Russell, 1980). Valence refers to how negative or positive a stimulus is. For example, the word "death" is negative in valence due to its adverse connotations, while "happy" is positive in valence. Arousal, on the other hand, is how interesting or relevant we find a stimulus. A word like "the" is considered low in arousal because it is common and fails to interest us, whereas our first name is a highly arousing word due to its ability to capture attention. The importance of these two dimensions has been repeatedly emphasized by the current body of work on emotion.

Categorical Negativity Theory

The relationship between emotion and attention is complex and not completely understood; however, there are currently two widely-accepted theories as to how emotional stimuli impact our attention. The first, categorical negativity theory, is a model of processing supporting the idea that we continuously evaluate stimuli in our environment to rank and prioritize the order in which we respond to them (Pratto & John, 1991). According to categorical negativity theory, we constantly and automatically judge the stimuli in our surroundings on the basis of valence, or how positive or negative they are. Subsequently, we rank the priority of these stimuli by negativity. This continuous ranking provides us with a hierarchy for which stimuli to attend to first. According to categorical negativity theory, stimuli are mainly classified by category and thus all category members are attended to similarly; therefore, all negative stimuli, regardless of the degree of negativity, should elicit similar responses (Pratto & John, 1991).

Aligned with categorical negativity theory is the phenomenon of automatic vigilance, which occurs when emotional stimuli in the environment influence and bias the subsequent processing of information (Estes & Adelman, 2008). Similar to categorical negativity, automatic vigilance purports that all negative words attract attention before neutral or positive words. Automatic vigilance also supports the idea that all negative words, ranging from slightly negative to extremely negative, capture attention equally.

From an evolutionary standpoint, categorical negativity and automatic vigilance make sense; as one of the main goals of human existence is continued survival, we typically attend to negative stimuli first (Juslin & Laukka, 2003). By responding to the stimuli we find to be negative, we are likely prioritizing the most dangerous and aversive ones. For example, our survival odds are probably better if we automatically attend to the tiger (negative) in our environment before the butterfly (neutral/positive). Categorical negativity theory also states that all negative stimuli, regardless of their level of negativity, capture attention equally. This is likely true because it is more advantageous for survival to overreact to a mild stimulus than to underreact to a very dangerous stimulus; therefore, it is prudent to treat all negative stimuli as important (Juslin & Laukka, 2003). Unnecessarily reacting to something like a dog barking is well worth the expenditure of attention when the alternative could be not responding quickly enough to the snarl of a wolf. Multiple studies provide experimental support for categorical negativity theory (e.g., Estes & Adelman, 2008; Pratto & John, 1991; Sutton & Altarriba, 2011), so it seems as though negative stimuli do influence and capture our attention more easily than other types of stimuli.

Diverse methodologies and paradigms all provide support for automatic vigilance; these studies can be broken down and classified into visual search, filtering, cuing, lexical decision, and multiple task paradigms (Cowan, 2005; Yiend, 2010). Visual search tasks require participants to find one or more stimuli among multiple stimuli as a way to examine where attention is drawn first. Many studies utilizing visual search paradigms support the categorical negativity model and automatic vigilance (e.g., Eastwood, Smilek, & Merikle, 2001; Juth, Karlsson, Lundqvist, & Ohman, 2000). For example, Gerritsen, Frischen, Smilek, Blake, and Eastwood (2007) revealed that when participants were asked to search a variety of neutral facial stimuli for threatening or peaceful expressions, it took much less time to locate a threatening face than a peaceful one. Together, this body of work indicates that negative information is detected faster than any other information and is the most distracting type of visual information. Frischen, Eastwood, and Smilek (2008) reviewed a number of studies using visual search paradigms with emotional information (e.g. words, faces, images); they, too, concluded that attention is sensitive to (and easily manipulated by) negative emotion.

Support for automatic vigilance also comes in the form of studies with filtering tasks, which present both target and distracting stimuli together and test participants' ability to suppress or attend to certain stimuli. One of the most common filtering tasks used to study the relationship between emotion and attention is the emotional Stroop task (Larsen, Mercer, & Balota, 2006; Pratto & John, 1991; Wentura, Rothermund, & Bak, 2000), in which participants try to quickly identify the ink colors of various words that are presented to them. In one such study, Pratto and John (1991) discovered that it took participants more time to name the ink color of an undesirable negative trait (e.g. "sadistic") than a desirable positive one (e.g. "honest"). The lengthened response time to negative stimuli is indicative that negative words automatically demand more attentional resources than neutral or positive words, thereby requiring more time for participants to disengage from the word meaning before being able to report the ink color. Additionally, Pratto and John (1991) did not find any response latency differences in negative words regardless of the degree of negativity, and these findings were successfully replicated by Wentura et al. (2000) using a similar design. They confirmed that negative stimuli are "more heavily weighted and trigger more elaborate attention processes" than other types of words (Wentura et al., 2000, p. 1034). This data is consistent with both automatic vigilance and the categorical negativity model.

Cuing tasks also support categorical negativity and automatic vigilance. Cuing tasks use a stimulus or event to draw attention to a particular location, and are often followed by a target stimulus to be detected. One such task is the dot-probe task. By visually cuing participants in two separate locations, dot-probe tasks act as a way to examine how negative stimuli affect the way attention is distributed (Yiend, 2010). Sutton and Altarriba (2011) asked participants to view two words differing in valence on a screen and respond to a subsequent neutral probe stimulus. Participants responded more quickly to the probe when it appeared close to the location of a negative word, compared to a neutral or positive word, and regardless of whether or not the words were masked after presentation and before the target probe. These results provide more support for automatic vigilance; this is an indication that participants paid more attention to negative stimuli than positive or neutral stimuli and were able to recognize the probe in that area more quickly due to the increased attentional resources directed to the location. Sutton and Altarriba (2011) concluded that negative stimuli capture our attention more easily than neutral or positive stimuli.

Experimental evidence supporting categorical negativity also comes in the form of studies utilizing lexical decision tasks. Lexical decision tasks require participants to examine a stimulus and classify it as quickly as possible, thereby examining reaction time and attention. Estes and Adelman (2008) hypothesized that when participants were presented with positive and negative words, automatic vigilance would result in slower lexical decision times for negative words than positive words due to their automatic capture of attention. After gathering words from the Affective Norms for English Words database (ANEW; Bradley & Lang, 1999) and controlling for lexical factors like word frequency and length, Estes and Adelman found that response times were shorter for positive words than negative words. This is consistent with automatic vigilance and categorical negativity theory because the longer response times for negative words indicate that attention is captured by negativity, and it takes longer for this attention to be disengaged from negative stimuli than positive stimuli (for a similar argument, see Horstmann, Scharlau, & Ansorge, 2007). Additionally, regardless of the degree of negativity, all negative words produced equal automatic vigilance effects.

Finally, multiple task paradigms are another source of evidence that negative emotional stimuli categorically impact attention (e.g. Anderson, 2005; Keil & Ihssen, 2004; Most, Smith, Cooter, Levy, & Zald, 2007). Multiple tasks force participants to attempt to meet more than one demand, thereby testing their limited attentional and processing capacities. Most commonly, studies using multiple tasks to examine emotion and attention rely on the rapid serial visual presentation (RSVP) paradigm. In the RSVP paradigm, a series of stimuli are presented rapidly, usually between 75-125 ms each, and participants attempt to report two target stimuli (Target 1 (T1) and Target 2 (T2)) that appeared in the list. Typically, if the two target stimuli are presented within 200-500 ms of one another, the second target goes unnoticed, a phenomenon known as attentional blink (AB) (Petrucci & Pecchinenda, 2017). When the second target is presented during this time frame, participants have trouble reporting it with accuracy, as compared to a second target presented either immediately after T1 or more than 500 ms after the first target (Broadbent & Broadbent, 1987). Although this phenomenon has been well documented and is the subject of countless studies, there is still debate over the mechanism responsible for producing the AB effect.

Milders, Sahraie, Logan, and Donnellon (2006) used emotional faces as stimuli in an RSVP paradigm and found that participants were able to detect and identify T2 more frequently and accurately if the first stimulus was a negative emotional face instead of a neutral or positive face. These results were explained by the authors as a consequence of the differences in attention allocation between negative stimuli and positive and neutral stimuli. The increased attention for subsequent stimuli after the presentation of a negative face was a result of the attention capture by the negative face, resulting in increased attention and a higher likelihood of second stimulus detection. Additionally, Most and Junge (2008) noticed that retroactive effects can occur when unpleasant stimuli are presented after neutral stimuli; this means that the stimuli presented later in the stream can actually impact stimuli that were presented earlier in the sequence.

Most and Junge (2008) found that target identification accuracy was impaired by showing a negative image after the presentation of the target. These findings were explained as a function of the high attentional capture of negative images compared to neutral images. The negative images become consolidated in memory more easily due to their automatic attention capture and tend to be remembered better than the neutral images. These studies all provide support for the idea that negative emotional stimuli can influence the attention allotted for stimuli presented prior to and after the negative stimulus. Keil and Ihssen (2004) used the RSVP paradigm to test how pleasant, unpleasant, and neutral words would affect attention to the second target stimulus. Both pleasant and unpleasant words increased the accuracy of correctly identifying the second target stimulus. Anderson (2005) found similar results in a subsequent study, in which the attentional blink impairment was significantly alleviated when the target words were emotional. The increase in performance as a result of viewing pleasant words suggests that there may be other factors besides valence that influence attention, such as arousal.

Arousal Hypothesis

A second model of emotional processing suggests that attention is also impacted by arousal, or how much a stimulus triggers a sympathetic physiological reaction (Russell, 1980). This model, called the arousal hypothesis, argues that emotional stimuli elicit attention on the basis of how relevant and/or arousing they are, regardless of their valence. The results of Keil and Ihssen (2004) and Anderson (2005) cannot completely be explained by categorical negativity theory. Both studies found that positive words, as well as negative words, had an impact on reaction time, which implies that something other than the valence of the stimulus must be responsible.

Since these findings cannot entirely be addressed with categorical negativity theory and automatic vigilance, the arousal hypothesis may serve to explain what categorical negativity cannot. Keil and Ihssen (2004) directly measured and reported the arousal ratings of the words used in their study (the mean arousal rating was 7.06 for pleasant words, 2.61 for neutral words, and 7.62 for unpleasant words), while Anderson (2005) simply noted that the arousal values of positive and negative words used in their study were higher than the ratings of stimuli used for neutral words. These studies fit well with the arousal hypothesis because both Keil and Ihssen (2004) and Anderson (2005) demonstrated that highly arousing stimuli, regardless of valence, determine how much attention the stimulus receives.

As discussed, categorical negativity argues that our attentional resources are biased towards stimuli that resemble threats to our safety for which we have been biologically prepared. This means that it served our survival well to recognize shapes like snakes, bears, and tigers, but since the categorical negativity model is based on threat, it argues that there should be no reason for positive emotional stimuli to bias our attention. However, this is not always the case—we know that we often do pay attention to positive emotional stimuli (Ohman, Lundqvist, & Esteves, 2001). This can be argued from an evolutionary standpoint too. It would be important to our survival, and our survival as a species, to recognize threats but also respond to positive emotional stimuli, like the sight of a smiling baby's face. Biological needs like food and drink, which are necessary for our survival, have the ability to bias our attention as well. Depending on the state of thirst or hunger, the arousal values of these items also fluctuate.

There is also a biological explanation behind the arousal hypothesis. It is proposed that the amygdala is the brain structure responsible for the impacts of emotion on attention (Anderson et al., 2003). The amygdala is involved in processing both negative and positive stimuli that are high in arousal and is also responsible for controlling the enhanced perceptual processing behind the attentional bias to highly arousing stimuli (Anderson & Phelps, 2001). As a result, positive stimuli also capture attention if they are high in arousal.

It is important to note that the amygdala is crucial because the arousal value of a stimulus is subject to change depending on the relevance of the stimulus to a person's concerns, desires, values, and needs (Frijda, 1988). Relevance may be permanent, as with hearing our own name, or temporary, like searching for the color blue when trying to find the right car in a parking lot (Klinger, 1975). Therefore, due to our rapidly fluctuating needs and the constant influx of sensory information, the amygdala arose as a mechanism to rapidly detect stimuli that are relevant to our current concerns (e.g., Brosch, Sander, Pourtois, & Scherer, 2008; Brosch, Scherer, Grandjean, & Sander, 2013). If a stimulus is appraised by the amygdala and deemed relevant, based on valence and arousal, it is able to subsequently capture and influence attention; if not, it does not gain access to our attentional resources. This is useful in helping us to evaluate and appraise stimuli, but the amygdala also has the power to enhance the cortical representation of stimuli to make them appear more salient, disproportionately influencing and biasing our attention (Sander, Grafman, & Zalla, 2003).

As the relevance of a stimulus is important in determining its arousal level, it has been proposed that the biological relevance of a stimulus is a contributing factor to the attention the stimulus will receive (Schimmack, 2005). Brosch et al. (2008) decided to test this by manipulating relevance. In order to make their test stimuli equally relevant, Brosch et al. (2008) chose to use pictures of baby faces and angry adult faces. The infant faces served as biologically relevant positive stimuli, while the angry adult faces acted as biologically relevant negative stimuli. The authors wrote that both conditions equally inspired some type of action; the baby faces elicited nurturing behavior while the angry adult faces triggered a “fight or flight” response. The authors found that when relevance is held constant, people are equally attentive to positive and negative faces. These findings dispute categorical negativity theory, while providing support for the idea that arousal modulates attention.

In addition to relevance, attentional bias towards positive stimuli has been shown to increase as the arousal values of the stimuli increase as well (Pool et al., 2016); therefore, there is a positive relationship between arousal and attention. A meta-analysis by Pool et al. (2016) examined 243 studies to explore how positive and neutral stimuli impact attention. Overall, a marginal effect of arousal on attention was discovered such that as the arousal level of a stimulus increased, so did the attention it received. Their results also indicated that the characteristics of a stimulus determine how much attention it will capture. For example, studies using images as stimuli elicited a larger attentional bias than studies utilizing words.

Additionally, when a stimulus represented a specific area of concern or interest (e.g. an image of a glass of wine to someone with alcohol use disorder), it elicited more of an attentional bias than a stimulus that was more general or less salient. These findings are consistent with the arousal hypothesis since more attention was directed to stimuli relevant to the individual's specific needs and concerns.

By using a variety of paradigms that examine early versus late attention, we can determine more specifically which attentional processes are impacted by emotional stimuli. It is typically thought that paradigms that measure early attention reflect more automatic, involuntary processes, while paradigms examining later attention are more indicative of conscious, controlled attentional processing (Yiend, 2010). A study by Leite et al. (2012) provides support for the notion that more conscious and voluntary attentional resources get directed to stimuli that are higher in arousal. The authors used event-related potential (ERP) data to measure participants' brain responses to images with different valence and arousal ratings. It was found that highly arousing images, regardless of valence, received increased attentional resources during processing, as evidenced by larger amplitude late positive potential brain waves. Late positive potential brain waves are an indicator of explicit recognition memory, meaning that participants devoted more attentional resources to processing stimuli high in arousal than stimuli low in arousal. A related study found that when people were shown a highly arousing image and a low arousing image at the same time, they would respond much more quickly to a stimulus that appeared after the images in the same location as the highly arousing image compared to the low arousing one, regardless of valence (Vogt, De Houwer, Koster, Van Damme, & Crombez, 2008). This indicates that arousal automatically captures attention and is a determining factor in how many attentional resources are devoted to a stimulus. Additionally, this work suggests that arousal has a positive relationship with attention; the higher the level of arousal, the more attention a stimulus will receive.

Many studies actually support the idea that both arousal and valence play a role in attentional capture (e.g., Fernandes, Koji, Dixon, & Aquino, 2011; Larsen, Mercer, Balota, & Strube, 2008; Pool et al, 2016). Fernandes et al. (2011) presented participants with a series of positive and negative high and low arousal images while they completed a digit parity task. Each image was presented with a digit on either side, and participants were asked to decide whether or not the digits on either side of the image were similar (e.g. both odd or even numbers). It was found that high arousal negative images elicited poor performance on the digit parity task as compared to high arousal positive images. Interestingly, low arousal negative images actually facilitated performance as compared to low arousal positive images. This suggests that both valence and arousal interact to influence attention. Specifically, the “arousal level of images modulates the influence of valence on distribution of visual attention” (Fernandes et al., 2011, p. 1191). Although this is consistent with the idea that negative emotional images capture attention, other factors are involved in attention capture, such that even low arousing positive stimuli can capture and influence attention.

Consistent with the idea that valence and arousal are both involved in attention, two different studies conducted on the same data set provide support for both categorical negativity theory and the arousal hypothesis. Larsen et al. (2008) used the same set of data as Estes and Adelman (2008), whose results provided support for categorical negativity theory.

Larsen et al. (2008) controlled for many lexical characteristics, like orthographic neighborhood, that were unaccounted for by Estes and Adelman (2008). While Estes and Adelman determined that response times were longer for negative words than positive ones, providing support for categorical negativity, Larsen and colleagues determined that lexical decision times were longer for negative words that were high rather than low in arousal. This indicates that there is an interaction between valence and arousal. Both dimensions of emotion work together to influence the attentional capture and subsequent processing of stimuli.

Overall, neither categorical negativity theory nor the arousal hypothesis alone provide a complete explanation as to how and why emotional stimuli influence and capture our attention. This topic is still quite complicated and controversial. There are two opposing theories as to how emotion captures attention, and both theories make valid points as to the nature of emotion and attention. Some studies provide evidence for only one theory while others support both. Although much is still unknown, it is hoped that the current study will shed more light on how arousal and valence interact to influence attention while processing emotion words within sentences.

Processing Emotion Words Within Sentences

While most of the previous work examining the relationship between emotion and attention has focused on single words, there is a small body of work examining the impacts of emotional words on attention within sentences. Martín-Loeches et al. (2012) used event related potentials (ERPs) to investigate the effects of valence on syntactic and semantic processing while reading sentences. Participants were shown sentences containing target words that were neutral, negative, or positive emotional words. The sentences were either syntactically correct (e.g. “The sister arrives”) or incorrect (e.g. “The sisters arrives”) in Experiment 1 and semantically correct (e.g. “The loved sister arrives”) or incorrect (e.g. “The gratuitous sister arrives”) in Experiment 2. In Experiment 1, an ERP component called left anterior negativity (LAN), which elicits a response when grammatical anomalies (like morpho-syntactic violations) occur, displayed larger amplitudes with syntactic negative emotion word violations than syntactic neutral word violations, while syntactic positive emotion word violations elicited the smallest amplitudes of all. This is called a negativity bias; it indicates that the emotional valence of a word directly affects the attentional processes related to syntactic judgment (Martín-Loeches et al., 2012). A similar ERP study by Holt, Lynn, and Kuperberg (2009) found that participants also displayed a negativity bias in the late positive component (LPC). The LPC is an indication of attentional processing and is often evoked by words that violate the syntactic and/or semantic structure of the surrounding context, similar to LAN. The presence of the negativity bias indicates that emotional processing networks have the capacity to influence the construction of a word’s emotional meaning. These emotional processing networks simultaneously influence several stages of this emotional language construction (Holt et al., 2009). This work suggests that emotional words capture and influence attention on several levels of word processing. Understanding the emotional meaning of words within a neutral context first requires an initial analysis of the words in the sentence, and emotional words capture attention more easily than neutral words. A secondary, more in-depth semantic analysis process then distinguishes the valence of emotional words. It is important to note that this negativity bias is consistent with categorical negativity theory.

Bayer, Sommer, and Schacht (2010) also used ERP to examine how we read emotional words within sentences, and examined how both valence and arousal play a role in this process. Participants were asked to read sentences and perform a semantic decision task on the target words (which varied in valence and arousal) within the sentences. Interestingly, emotion effects were also most evident in the LPC, which is linked to language processing and memory (Bayer et al., 2010). When target words were negative and high in arousal, they elicited the greatest LPC. This indicates that the LPC is modulated by both valence and arousal. Surprisingly, when valence was controlled and only arousal levels were manipulated, the LPC was not affected. The authors of the study were surprised by this finding, but concluded it was unlikely that the findings were due to a lack of power (Bayer et al., 2010). These results emphasize the importance of valence, which is consistent with categorical negativity theory.

Another way to examine how we process emotion words in sentences is to use the RSVP task. Often, words appear more than once in the sentences we read. Research has shown that participants can understand and recall RSVP sentences shown at rates as fast as 10-12 words per second (Potter, Kroll, Yachtzel, Carpenter, & Sherman, 1986), but have difficulty recalling nonword lists of only four or five words shown at the same rate (Potter, 1984). This is evidence that participants are able to process the sentence as it is read, as opposed to remembering individual words and reconstructing the sentence later (Potter, 1984). Although there is a processing advantage with full sentences, there is evidence that repetition blindness (RB) may occur when words are repeated in the same sentence (Potter, Moryadas, Abrams, & Noel, 1993).

As discussed previously, the RSVP paradigm has been utilized in many studies to examine interactions between attention and emotion. In addition to the attentional blink effect reported in the literature, RB effects are examined using this paradigm. RB is an attentional deficit that occurs if an identical, or very similar, word is presented as the second target in an RSVP paradigm; participants will often be unable to recall seeing the second target word. Repeated words are actually recalled more poorly than unrepeated words (Kanwisher, 1987). AB and RB are often considered to be related because both phenomena are caused by the limits of the attentional system. Both AB and RB provide us with an indication of how attention is allocated to stimuli (Arnell & Shapiro, 2010). Repetition blindness can be explained by the token individuation model, which describes this effect as an error in nodes, or the way we mentally represent and map stimuli (Kanwisher, 1987). We rely on two different nodes, token and type nodes, to mentally map and represent language. Type nodes are mental representations of things that become activated after seeing a stimulus. For example, when seeing a sentence about a flower, the type node for “flower” would be activated. On the other hand, token nodes work more spatially and represent the relative position of something (Knickerbocker & Altarriba, 2013). They are tied to type nodes; for example, the token node of “flower” would indicate that it was the fifth word in a sentence. Type and token nodes become mentally tied together to represent specific instances in time (Kanwisher, 1987). Therefore, when a word is presented more than once, two type nodes for the repeated word become tied to the same token node. This results in confusion since two activations of the same word are linked to the same instance. Ordinarily, we can handle this “double binding” if we are allowed the processing time to sort out these disparities; however, the rapid pace of the RSVP paradigm forces us to forego binding the second type node to the token node (Abrams, Dyer, & MacKay, 1996).This indicates that the repetition blindness effect occurs due to a failure in token individuation.

Neill, Neely, Hutchison, Kahan, and VerWys (2002) examined how temporal cues (e.g. time) and spatial cues (e.g. location) impacted RB, and proposed a modified account of Kanwisher's (1987) theory. Neill et al. (2002) presented participants with a fixation cross, followed by one letter each sequentially presented to the left and right of fixation, then masked. Participants were then asked to report a letter of each trial, either cued by temporal position or spatial location. Although a lack of distractor stimuli seems odd in RB research, this study was based off work by Luo and Caramazza (1995) demonstrating RB can occur with as few as two letters per trial. Luo and Caramazza (1995) found that subjects had difficulty reporting the second of two letters when both letters were identical. As there were only two letters, it seems highly unlikely such a minimal memory load was causing retrieval difficulties; therefore, RB occurred due to impaired perception of the repeated stimulus, even in the absence of other stimuli. Neill et al. (2002) reported that overall, there was far less recall accuracy when two repeated letters were in the same trial (the hallmark of RB), for letters in both left and right positions. The authors noted that if subjects were expecting temporal cues, the second letter experienced lower recall rates, but if they were using spatial cues, than performance on the first letter suffered. Interestingly, when they could not anticipate if the cues were temporal or spatial, then the cue type had no impact on recall of either letter. This suggests that the targets are not encoded independently of each other, as previous theories propose (e.g. Kanwisher, 1987; Whittlesea, Dorken, & Podrouzek, 1995). Instead, the relative magnitude of RB appears to also depend on presentation order and location.

Silvert, Naveteur, Honoré, Sequier, and Boucart (2004) used the RSVP paradigm to examine emotional language and found differences in the way emotional words are processed compared to neutral and animal-neutral words (included because the authors thought the negative emotion words might appear like a single category and selected animal-neutral as a second semantically homogenous neutral word category). When all words were shown once in the RSVP paradigm, participants had much higher recall accuracy for emotional words than neutral or animal-neutral words, likely due to an emotional memory enhancement effect. The emotional memory enhancement effect is a phenomenon where emotional stimuli are remembered better than non-emotional stimuli (Rubin & Friendly, 1986). This is likely due to the fact that only emotional stimuli get partially processed in the basolateral amygdala, which enhances hippocampal consolidation of emotional information compared to neutral information (Sommer, Glascher, Moritz, & Buchel, 2008), However, when words were repeated in the paradigm, accuracy of recall for emotional words was significantly lower than that of animal-neutral words, but not neutral words. Emotion words were more salient and distinct in the unrepeated trials, but more susceptible to repetition blindness and less easily recalled during repeated word trials. The results indicate that the change in size of the repetition blindness effect is a result of the differences in emotional association between neutral and emotional words. This is evidence that token individuation is much more difficult for emotion words than neutral words (Silvert et al., 2004). MacKay, Hadley, and Schwartz (2005) conducted a similar study using the RSVP paradigm with taboo and neutral words. As taboo words are emotionally salient, a similar repetition blindness pattern was obtained. Together, these studies provide evidence that word meaning, specifically emotional connotations, impacts the magnitude of the repetition blindness effect (MacKay et al., 2005).

To test the effects of emotional words on repetition blindness, Knickerbocker and Altarriba (2013) used an RSVP paradigm with both single words (Experiment 1) and full sentences (Experiment 2) containing target and distractor stimuli. As the authors pointed out, Silvert et al. (2004) intermixed emotion and emotion-laden words in the emotion word condition for their study, which could have influenced their results. Emotion words are words that label a direct emotion state, like “happy” or “sad,” while emotion-laden words have an emotional connotation, like “wedding” or “coffin.” In Experiment 1, Knickerbocker and Altarriba (2013) used pairs of emotion words, emotion-laden words, and neutral words as target stimuli. The target pairs consisted of identical words and were shown to participants in an RSVP task amongst a string of distractor symbol items. Half of all trials were unrepeated, meaning that only one word from each target word pair was displayed in the RSVP paradigm. The inclusion of the unrepeated condition was designed to measure RB. Participants recalled repeated target words at significantly lower rates than unrepeated target words. Word type was also statistically significant; emotion words were much more susceptible to RB effects on repeated trials. This effect was explained by the authors as evidence for the token individuation model, where two type nodes are linked to the same token node, thereby creating confusion and an error in perceptual processing. However, the emotion words actually exhibited higher recall rates than neutral words on unrepeated trials. Since words with direct emotional associations were perceived and recalled with higher accuracy, this supports the idea that emotion can directly affect attention. The same target words and word pairs were used again in Experiment

2, but presented in the context of full, grammatically correct sentences. In this task, repeated targets were recalled at a significantly lower rate than unrepeated targets. Emotion words had significantly higher recall rates than emotion-laden and neutral words in the unrepeated trials. Additionally, emotion words resulted in significantly lower accurate recall in repeated trials than neutral and emotion-laden words, while neutral and emotion-laden words did not differ significantly. Overall, emotional words produced the largest RB effects in both experiments.

Current study

While RSVP paradigms are useful in studying the relationship between emotion and attention, they often are not representative of real life. It is exceedingly rare to stumble upon a list of random words being rapidly and briefly presented one at a time. Instead, we typically see and read full sentences of text in daily life. While the body of work on emotion has grown tremendously over the years, much is still unknown about emotion and language, specifically in the domain of sentence processing (see Bayer et al., 2010; Martín-Loeches et al., 2012). Therefore, it seems beneficial to use full sentences in an RSVP paradigm, similar to the second experiment by Knickerbocker and Altarriba (2013).

Knickerbocker and Altarriba (2013) manipulated valence, but held arousal constant. On ANEW's (Bradley & Lang, 1999) 9-point scale to rate the valence and arousal of words, the emotional words used had an arousal rating of 6.06, the emotion-laden words had an average arousal rating of 5.80, and the neutral words averaged 4.41 in arousal. The current study aimed to explore the impacts of valence <u>and</u> arousal on emotion and attention in the context of natural reading. Positive and negative emotion words varying in arousal were used as stimuli to examine how these dimensions of emotion interact. This allowed us to test both categorical negativity theory and the arousal hypothesis. Only emotion-label words were used because recent studies have shown that emotion-laden and emotion-label words are processed differently within the brain (Altarriba & Basnight-Brown, 2011; Zhang, Wu, Meng, & Yuan, 2017); thus, to control for these differences, only emotion-label and neutral words were utilized.

As this study was designed to examine two opposing theories, there were two potential patterns of results that we expected to see. Low T2 recall rates for negative emotion words, regardless of arousal, in repeated trials would support categorical negativity theory. Additionally, it was expected that negative emotion words would be recalled at significantly higher rates than positive emotion words and neutral words in the unrepeated trials. On the other hand, low T2 recall rates for positively and negatively valenced emotion words high in arousal would support the arousal hypothesis. Consistent with the arousal hypothesis, it was expected that positive and negative words high in arousal would be remembered far more frequently than low- and moderate-arousal positive, negative, and neutral words in the unrepeated trials. In both cases, it was expected that recall of repeated targets would be significantly lower than recall of unrepeated targets, consistent with the RB effect.

Method

Seventy-four participants (36 male, 38 female) between the ages of 18-44 (M = 19.68, SD = 3.35) were recruited through Rochester Institute of Technology's online participant pool. To sign up, participants were required to be 18 years or older and speak English as a first language. It was also required that participants have normal or corrected-to-normal vision. Four participants were hard of hearing, one participant reported two prior concussions, and one participant noted a language disorder diagnosis under Pervasive Development Disorder—Not Otherwise Specified. No data was removed. Five participants indicated they were taking psychotropic medications, and all reported being stabilized (characterized by at least three months of consistent use). Participants were awarded class credit for their involvement with the study.

As previous work has demonstrated that anxiety and depressive disorders can impact the processing of negative stimuli (Trippe, Hewig, Heydel, Hecht, & Miltner, 2007), participants were screened for atypically high levels of anxiety and/or depression. The State Trait Anxiety Inventory Form Y-2 (STAI; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983) was used to assess trait and state anxiety, while the Beck Depression Inventory II (BDI-II; Beck, Steer, & Brown, 1996) was utilized as a measure of depressive symptoms. Participants who surpassed the predetermined scores of 13 for the BDI-II were considered high in symptomatology for depression, while scores above 42 on the STAI Y-2 were considered indicators of high symptomatology of anxiety. The BDI-II and STAI-Y2 scores were initially going to be used as exclusionary criteria, so any participants who scored above cutoff on one or both measures would be excluded from the study. However, as an unexpectedly high number of participants scored above cutoff for one or both measures, it seemed prudent to include all participants and use the BDI-II and STAI-Y2 scores as factors in the analyses instead.

Materials

The ANEW database (Bradley & Lang, 1996) was used to select 48 English words. Ratings of arousal and valence from ANEW were used as a way to quantify the degree of emotional association (valence) and amount of energy (arousal) that each word represents.

Valence is rated on a 9-point scale; scores ranging from 1-3 are indicative of negative valence, 4-6 means that the word is moderate in valence, and scores from 7-9 mean that the word is positively valenced. For the arousal dimension, scores from 1-3 indicate low arousal, while 4-6 are moderate in arousal and 7-9 are high in arousal. As neutral words do not have any emotional associations, they typically fall between 4-6 in both valence and arousal.

For stimuli, eight positive high-arousal words, eight positive low-arousal words, eight negative high-arousal words, eight negative low-arousal words, and 16 neutral words were selected (see Table 1 for a list of words used). Independent samples t-tests were utilized to ensure valence was held constant across negative low arousal and negative high arousal words, ($t(19) = 0.68$, $p > .05$) and positive low arousal and positive high arousal words, ($t(21) = -1.71$, $p > .05$) by comparing the two different means (e.g. low and high arousal means) of each valence. Similar independent samples *t*-tests were conducted to confirm that arousal levels were consistent for positive and negative low arousal words, ($t(17) = 1.80$, $p > 0.5$), as well as for positive and negative high arousal words, ($t(22) = 0.80$, $p > .05$). Analysis of variance indicated that words in all categories were also matched on word length, ($F(3,44) = 1.20$, $p > .05$), and word frequency, ($F(3,44) = 0.70$, $p > .05$). The various word characteristics are reported in Table 2. The words were used to create repeated and unrepeated trials for each word type condition. Words were shown once in unrepeated trials and twice in repeated trials within the context of full-sentence reading. Forty-eight full, grammatically correct sentences were used. The sentences contained 10-14 words each. Target stimuli appeared in the approximate middle of each sentence in both repeated and unrepeated trials. On each trial, the target word pairs were separated by 1-3 other words. This word gap between targets, known as average lag, was held constant across all target types so as not to influence the results. For the sentences, see the Appendix.

As mentioned, participants were screened for depression and state and trait anxiety with the BDI-II and STAI. The BDI-II is a self-report measurement designed to assess the severity of any existing symptoms of depression during the past two weeks, including the day of the assessment. The BDI-II contains a total of 21 items; items are scored on a scale from 0-3, based on the severity of each item. Scores from 0-13 indicate minimal depression, 14-19 signify mild depression, 20-28 suggest moderate depression, and 29-63 are considered severe depression (Beck, Steer, & Brown, 1996). Participants scoring 13 or above on the BDI-II were considered as having symptomatology for depression. In our sample, the mean score was 11.22 (*SD* = 8.71). Our sample had high internal consistency for the BDI (Cronbach's alpha = 0.90). The STAI Y-2 includes 20 questions assessing for state anxiety. Items are scored on a scale of 1-4 based on how much the test-taker agrees with each item provided. Scores of 42 and above are indicative of high state anxiety (Spielberger et al., 1983), and participants in this scoring range were considered as having symptomatology for anxiety. In our sample, the mean STAI Y-2 score was 36.91 (*SD* = 10.00). Internal consistency was also high (Cronbach's alpha = 0.91).

As research has shown that negative words can impact the subsequent recognition and judgment of positive words, stimuli were split into two blocks of 32 trials each (or 64 total, with four repeated and four unrepeated sentences per emotion condition and eight repeated and unrepeated trials each for neutral words). In the first block, all trials contained only positive and neutral stimuli. The second block consisted of negative and neutral stimuli only. All participants viewed both blocks, and the sentences within each block were pseudorandomized.

Procedure

The entire procedure lasted approximately 30 min. After completing an informed consent form, participants were seated in front of a computer. They were then asked to complete paper versions of the BDI-II and STAI Y-2, as well as a demographics questionnaire. Next, participants were asked to turn their attention to the computer screen, read the task instructions, and give a verbal confirmation of understanding before proceeding. The task instructions were, "You are about to be presented with several sentences. Each word in the sentence will be presented very quickly. Sentences will appear on the screen one word at a time. Each sentence may contain all different words, or the same word could be used twice in the same sentence. Please report all words and repetitions separately. Please pay attention to the words on screen and be prepared to report the full sentence at the end of each trial when you see the following symbol: @@@@@@@." It was specified in the instructions that trials may contain a single target word or two repetitions of the same target word. Participants indicated understanding that if there were two target words, they must be reported separately. Each trial began with the presentation of a fixation cross in the center of the screen for 1000 ms. Immediately following the fixation cross, a sentence was presented in the RSVP paradigm. Each individual word in the sentence was shown in succession for 100 ms. To signal the end of the trial, a string of symbols appeared. Participants were asked to verbally report the full sentence immediately following the trial as a measure of recall. Consecutive trials followed as quickly as possible after the participant was done reporting. The experimenter controlled the pacing of trials with the click of a mouse, so the next trial was launched (e.g. the mouse was clicked) immediately after participants ceased speaking. Participant responses on each trial were recorded verbatim by the experimenter on paper. See Figure 1 for a sample trial sequence. There were eight practice trials before starting the experimental trials. Practice trials featured a separate set of neutral target words not used in the experimental trials. Participants did not have to meet a certain performance level on the practice trials to continue into the experimental trials, but it is important to note that the vast majority of participants seemed comfortable with the task and were able to perform it well by the time the practice trials ended.

SAM Ratings

A Self-Assessment Manikin (SAM) rating task (Lang, 1980) was carried out by a separate group of undergraduates at RIT to ensure that the words categorized as positive/negative and high/low arousal for the current study using ANEW were actually interpreted in the same manner by RIT students. This sample belonged to the same population (e.g. college students) as the sample for the main study. A separate sample was utilized to ensure that viewing the words in the task did not affect their valence and arousal ratings to the words at a later time. Participants for the SAM ratings were given a paper packet containing all the target words in a randomized order, as well as enough blank SAM valence and arousal scales to rate each target word. They were asked to rate each word on arousal and valence on the SAM scale, which is a pictorial representation of valence and arousal on a scale of one to nine. A value of one on the valence scale means that a word is very negatively valenced, and a value of nine indicates that a word is highly positively valenced. A value of one on the arousal scale means that the word is very low in arousal and a value of nine would mean that a word is very arousing and attention-capturing. Before beginning the task, participants were shown images of the SAM scales for valence and arousal and walked through how to use the scales to rate each word. They were given the following instructions: "Before we begin, here are examples of the kinds of words you will be viewing and rating. Right now, I'd like you to take your sample rating sheet and practice rating the following words, all on the same sheet. This is to help you get a feel for how the ratings are done. You have two packets in front of you. One contains all of the words, and the other contains the SAM scales. Please write the sheet number at the top of the word page on the top of the SAM scale packet as you rate the words. Please remember to make your ratings on both dimensions as quickly as possible. There are no right or wrong answers, and please rate every word on both dimensions. You should flip the pages of the word packet and the rating packet simultaneously, and always write the sheet number from the word page on top of the corresponding rating page. You also have a Demographics form. Please complete this form when you have finished rating all of the faces. When you complete the task, please review your packets carefully to be certain you have completed all ratings on all of the words. You can raise your hand when you finish and one of us will collect the packets." Participants were given as much time as needed to complete the ratings.

It is important to note, before getting into the Results, that two different sets of analyses were conducted. The data was first analyzed in pairs, meaning T1 and T2 had to both be correctly recalled, as a replication of Knickerbocker and Altarriba (2013). First, a 2 (repetition: repeated or unrepeated) x 2 (valence: positive or negative) x 2 (arousal: high or low) x 4 (mood score: High BDI, high STAI, high STAI and BDI, high on neither) mixed ANOVA and a 2 (repetition: repeated or unrepeated) x 2 (valence: positive or negative) x 2 (arousal: high or low) x 2 (mood score: High on one or both mood measures, high on neither mood measure) mixed ANOVA were run to assess the effects of mood measure scores, where mood was assessed with 4 levels (high BDI, high STAI-Y2, high on both mood measures, or low on both mood measures) and 2 levels (high on one or mood mood measures or low on both mood measures), respectively. A 2 (repetition: repeated or unrepeated) x 2 (valence: positive or negative) x 2 (arousal: high or low) within-subjects repeated measures ANOVA was utilized to explore the pair data. Next, the data was examined by target location, where T1 and T2 recall were separately examined, as is common in RB literature (e.g. Neill et al., 2002). A 2 (repetition: repeated or unrepeated) x 2 (valence: positive or negative) x 2 (arousal: high or low) x 2 (target location: T1 or T2) within-subjects repeated measures ANOVA was run to examine target location data.

Results

SAM Analyses

Fifty-five participants (*M* age= 20.6, 52.7% male) total provided SAM rankings for the target words. This supplemental data was collected so it would be possible to tell whether participants actually perceived the valence and arousal levels of the target words similarly to the way the target words were ranked in ANEW. Overall, the sample gave valence and arousal ratings similar to those listed for the target words in ANEW. The only significant disparity was for the word “fireplace,” which was rated as neutral in both valence and arousal in ANEW, but ranked as fairly positive in valence (*M* = 6.45, *SD* = 1.35) and low in arousal (*M* = 3.24, *SD* = 1.94) according to our sample. Despite these differences, “fireplace” was retained as a target word. Therefore, it seems as though participants generally agreed with the valence and arousal classifications of our target words, and perceived them as such (see Table 1). Independent samples *t*-tests were run to determine if the average valence and arousal values for positive high arousal words, positive low arousal words, negative high arousal words, and negative low arousal words differed between the ANEW ratings and our SAM ratings. Overall, both ANEW and SAM raters gave similar ratings for all positive words included in this study. For positive high arousal words, there was no significant difference between the valence values ($t(22) = 0.91$, $p > .05$) and arousal values ($t(21) = -0.24$, $p > .05$) according to SAM and ANEW. Positive low arousal words were also deemed to have equal valence values ($t(22) = -1.10$, $p > .05$) and arousal values ($t(19) = 0.92$, $p > 0.5$) from SAM and ANEW. On the other hand, there were two disparities between ratings of negative words in ANEW and SAM. Low arousal negative words were judged to have the same average valence values from ANEW and SAM, ($t(22) = 0.8$, $p > .05$), but SAM participants rated the arousal values for low arousal negative words ($M = 2.45$, $SD = 0.92$) significantly lower than the values from ANEW ($M = 2.75$, $SD = 0.96$), ($t(19) = 1.95$, $p < .05$). The low arousal negative words were considered extremely low in arousal by the current sample of raters. Conversely, high arousal negative words were rated as having significantly lower valence levels by SAM participants ($M = 1.94$, $SD = 0.26$) as compared to ANEW ($M = 2.44$, $SD = 0.46$), ($t(17) = 3.28$, $p < .05$), but both gave these words equal average arousal ratings, ($t(21) = -1.34$, $p > .05$). The current raters deemed the negative high arousal words as more negative than the ANEW sample. Although these slight changes between ANEW and SAM were present, the overall agreement of valence and arousal ratings was important because it meant that our participants perceived the target words at the valence and arousal levels we had intended. The differences between SAM ratings and ANEW ratings do not seem to have serious implications because according to categorical negativity theory, as long as the words were perceived as negative, these slight differences in rating should not matter much, as all negative words are treated similarly (Juslin & Laukka, 2003).

Pair Recall Analyses

Data was first analyzed in pairs, to replicate Silvert et al. (2004) and Knickerbocker and Altarriba (2013). This means that both T1 and T2 had to be accurately recalled by participants to be considered correct. Accuracy rate means for the word pairs were computed for the different target repetition and word type (e.g., positive high arousal) conditions of the study. A 2 x 2 x 2 x 4 mixed ANOVA was conducted to examine the effects of repetition (repeated or unrepeated), valence (positive or negative), arousal (high or low), and mood scores (high BDI scores, high STAI scores, high BDI and STAI, or no high scores) on target word recall. As mentioned, BDI and STAI values originally meant to be used as cutoffs were now used to group participants by whether they scored highly on the BDI, the STAI, both, or neither. Of 74 participants, 12 scored highly on the BDI only, nine scored highly on the STAI only, 14 scored highly on both measures, and 39 did not score highly on either. According to the results, there was no main effect of mood score ($F(3,70) = 0.78$, $p > .05$), and no interactions involving mood score (all $p > .05$). Next, a 2 x 2 x 2 x 2 mixed ANOVA was conducted to examine mood scores in a binary fashion, such that participants either scored above the cutoff score on one or both mood measures, or did not score above the cut-off values on either measure. Of 74 participants, 39 did not score highly on either measure, while 35 scored highly on one or both measures. This analysis also revealed no main effect of mood score, ($F(1,72) = 0.18$, $p > .05$), or significant interactions involving mood score (all $p > .05$). As such, it was concluded that symptomatology, as indicated by mood scores, did not have any significant impacts on the results. In the present sample, with 74 participants, there were no effects in the results with symptomatology. Therefore, this variable was removed and a 2 x 2 x 2 within-subjects repeated measures ANOVA was performed to examine the effects of repetition, valence, and arousal.

There was a significant main effect of repetition, such that repeated target words (*M* = 2.49, *SD* = 1.16) were overall recalled more than unrepeated targets (*M* = 2.32, *SD* = 1.09), ($F(1,73) = 5.76$, $p < .05$, $\eta_p^2 = 0.07$). Three interactions were also significant. There was an interaction between valence and repetition, ($F(1,73) = 77.26$, $p < .05$, $\eta_p^2 = 0.51$) (see Figure 2). Follow-up analyses indicated that negative repeated words (*M* = 2.18, *SD* = 1.15) were recalled less than negative unrepeated words (*M* = 2.57, *SD* = 0.95), ($t(73) = -3.99$, $p < .05$), but the opposite was true for positive words—positive repeated words (*M* = 2.81, *SD* = 1.17) were actually recalled more than positive unrepeated words (*M* = 2.08, *SD* = 1.23), ($t(73) = 7.80$, $p < .05$). There was also an interaction between arousal and repetition, ($F(1,73) = 5.80$, $p < .05$, $\eta_p^2 = 0.07$) (see Figure 3). Follow-up analyses indicated that there was no difference in recall between repeated (*M* = 2.46 , *SD* = 1.20) and unrepeated (*M* = 2.45, *SD* = 0.93) high arousal words, but repeated low arousal words (*M* = 2.53, *SD* = 1.12) were remembered significantly better than unrepeated low arousal words (*M* = 2.20, *SD* = 1.26), ($t(73) = 3.14$, $p < .05$). Finally, there was an interaction between arousal and valence, ($F(1,73) = 13.44$, $p < .05$, $\eta_p^2 = 0.16$) (see Figure 4). Follow-up analyses indicated that there was no difference in performance on negative high arousal (*M* = 2.32, *SD* = 0.97) and negative low arousal word recall (*M* = 2.44, *SD* = 1.13), ($t(73) = -1.65$, $p > .05$); however, positive high arousal words (*M* = 2.60, *SD* = 1.15) were remembered better than positive low arousal words (*M* = 2.29, *SD* = 1.25), ($t(73) = 3.56$, $p < .05$).

To examine performance on the neutral words, a 3 x 2 within-subjects ANOVA was run to look at valence (positive, negative, or neutral) and repetition (repeated or unrepeated) on target word recall. Arousal was not included because neutral words are moderate in arousal, while the emotion words included had low or high arousal values. This analysis was consistent with Knickerbocker and Altarriba (2013), Experiment 2. No main effects were significant (all $p >$ .05); however, an interaction between repetition and valence was significant, ($F(2, 72) = 55.03$, $p < .05$, $\eta_p^2 = 0.44$). Neutral unrepeated words ($M = 5.30$, $SD = 1.93$) were recalled more than neutral repeated words ($M = 4.08$, $SD = 2.15$), ($t(73) = -5.76$, $p < .05$). The same was true for negative words, such that negative unrepeated words ($M = 5.15$, $SD = 1.67$) were better remembered than negative repeated words ($M = 4.36$, $SD = 2.10$), ($t(73) = -3.99$, $p < .05$). On the other hand, positive repeated words ($M = 5.62$, $SD = 2.10$) were recalled more than positive unrepeated words ($M = 4.15$, $SD = 2.20$), ($t(73) = 7.80$, $p < .05$) (see Figure 5).

Target Location Analyses

Results were also examined according to target location (whether participants correctly identified T1 and/or T2 separately from one another). In the literature, this is a common way to analyze repetition blindness (e.g. Fagot & Pashler, 1995; Kanwisher, 1991; Kanwisher & Potter, 1990; Neill et al., 2002). It is important to note that missing T1 or T2 can count as RB because, in the token individuation model, the T1 token node can sometimes migrate to the T2 position (Neill et al., 2002).

A 2 x 2 x 2 x 2 within-subjects repeated measures ANOVA was conducted to examine the effects of valence (positive or negative), arousal (high or low), target location (T1 or T2), and repetition (repeated or unrepeated) on mean target recall. No neutral data was included because they have moderate arousal values, which are not comparable to the high and low arousal values of the positive and negative words included in this study.

The analysis revealed a main effect of arousal ($F(1,73) = 3.98$, $p = .05$, $\eta_p^2 = .05$). Overall, high arousal words ($M = 3.10$, $SD = 0.80$) were remembered better than low arousal words ($M = 3.02$, $SD = 0.92$), ($t(73) = 2.00$, $p = .05$). A main effect of repetition was found, ($F(1,73) = 13.98$, $p < .05$, $\eta_p^2 = .16$), such that repeated words ($M = 3.15$, $SD = 0.84$) were remembered better overall than unrepeated words ($M = 2.97$, $SD = 0.88$), ($t(73) = 3.74$, $p < .05$). There was also a main effect of target location, ($F(1,73) = 180.13$, $p < .05$, $\eta_p^2 = .71$). Words located at T1 ($M = 3.55$, $SD = 0.64$) were recalled more often than words located at T2 ($M = 2.58$, $SD = 1.09$), ($t(73) = 13.09$, $p < .05$).

Several significant interactions were also discovered, such as the interaction between valence and arousal ($F(1,73) = 24.02$, $p < .05$, $\eta_p^2 = .25$), (see Figure 6). Positively valenced words were impacted such that high arousal positive words ($M = 3.15$, $SD = 0.87$) were remembered better than low arousal positive words ($M = 2.90$, $SD = 1.02$), ($t(73) = 2.10$, $p < .05$), while arousal had no significant effects on negative word recall. Negative high arousal words ($M = 3.05$, $SD = 0.74$) and negative low arousal words ($M = 3.15$, $SD = 0.83$) were recalled at similar rates, ($t(73) = -1.29$, $p > .05$).

An interaction between valence and repetition was also significant, ($F(1,73) = 43.73$, $p < .05$, $\eta_p^2 = .38$), (see Figure 7). Repetition appeared to facilitate the recall of positive words, such that repeated positive words ($M = 3.23$, $SD = 0.91$) were better recalled than unrepeated positive words ($M = 2.80$, $SD = 0.98$), ($t(73) = 6.46$, $p < .05$). Repetition did not impact negative words. Negative repeated words ($M = 3.05$, $SD = 0.78$) and negative unrepeated words ($M = 3.15$, $SD = 0.79$) were not significantly different in terms of recall accuracy, ($t(73) = 0.15$, $p > .05$).

There was an interaction of valence and target location, (*F*(1,73) = 20.35, $p < .05$, $\eta_p^2 = .38$, see Figure 8). Both positive T1 words (*M* = 3.44, *SD* = 0.73) and negative T1 words (*M* = 3.66, *SD* = 1.03) overall had a better recall rate than negative T2 words (*M* = 2.54, *SD* = 1.03), (t(73) = 13.43, $p < .05$) and positive T2 words (*M* = 2.61, *SD* = 1.15), (t(73) = 13.52, $p < .05$). Additionally, positive T1 words (*M* = 3.44, *SD* = 0.73) were remembered significantly less often than negative T1 words (*M* = 3.66, *SD* = 1.03), (t(73) = -4.22, $p < .05$).

Arousal and target location also had a significant interaction, (*F*(1,73) = 10.07, $p < .05$, $\eta_p^2 = .12$), (see Figure 9). High arousal T1 words (*M* = 3.63, *SD* = 0.57) were remembered more than low arousal T1 words (*M* = 3.46, *SD* = 0.70), (t(73) = 3.56, $p < .05$); however, high arousal T2 words (*M* = 2.56, *SD* = 1.03) and low arousal T2 words (*M* = 2.60, *SD* = 1.14) were not recalled at significantly different rates, (t(73) = -0.76, $p > .05$).

A significant repetition by target location interaction was also present, where repetition only seemed to impact words located at T1, (*F*(1,73) = 17.79, $p < .05$, $\eta_p^2 = .20$), (see Figure 10). Repeated T1 words (*M* = 3.71, *SD* = 0.57) were recalled significantly more often than unrepeated T1 words (*M* = 3.38, *SD* = 0.70), (t(73) = 7.10 , $p < .05$). Repeated T2 words (*M* = 2.59, *SD* = 1.12) and unrepeated T2 words (*M* = 2.57, *SD* = 1.06) were recalled at similar rates, (t(73) = 0.34, $p > .05$).

Finally, there was a significant three-way interaction between valence, repetition, and target location, (*F*(1,73) = 43.17, $p < .05$, $\eta_p^2 = .37$), (see Figure 11). For T1, positive repeated words (*M* = 3.62, *SD* = 0.57) were recalled more often than positive unrepeated words (*M* = 3.26, *SD* = 0.63), (t(73) = 4.59, $p < .05$). Negative repeated words at T1 (*M* = 3.80, *SD* = 0.40) were also recalled more often than negative unrepeated words at T1 (*M* = 3.51, *SD* = 0.43), (t(73) = 5.23, *p*

$< .05$). At T2, positive repeated words (*M* = 2.88, *SD* = 1.03) were actually remembered better than positive unrepeated words (*M* = 2.34, *SD* = 1.01), (t(73) = 5.60, $p < .05$). Negative unrepeated T2 words (*M* = 2.79, *SD* = 0.83) were recalled more often than negative repeated T2 words (*M* = 2.30, *SD* = 0.96), t(73) = -0.62, $p < .05$).

Neutral Data

Neutral data was also analyzed within a 2 (repetition: repeated and unrepeated) x 2 (location: T1 and T2) x 3 (valence: positive, negative, and neutral) within-subjects repeated measures ANOVA. Arousal was not included as a factor because neutral words are moderate in arousal, while the emotion words included in this study were either low or high in arousal. When neutral data was included in the target location analyses, there was a main effect of target location ($F(1,73) = 250.07$, $p < .05$, $\eta_p^2 = .77$). T1 words (*M* = 7.13, *SD* = 1.01) were overall recalled more than T2 words (*M* = 5.08, *SD* = 1.91), (t(73) = 13.09, $p < .05$).

There was a significant valence x repetition interaction ($F(2,72) = 29.41$, $p < .05$, $\eta_p^2 = .45$), (see Figure 12) such that positive repeated words (*M* = 6.50, *SD* = 1.61) were recalled significantly more often than positive unrepeated (*M* = 5.60, *SD* = 1.64) words, (t(73) = 6.46, $p < .05$). The reverse was true for neutral words. Unrepeated neutral words (*M* = 6.33, *SD* = 1.41) were actually recalled better than repeated neutral words (*M* = 5.81, *SD* = 1.48), (t(73) = -3.78, $p < .05$). Negative words were overall unaffected by repetition; negative repeated words (*M* = 6.11, *SD* = 1.36) were remembered similarly to negative unrepeated words (*M* = 6.30, *SD* = 1.27), (t(73) = -1.71, $p < .05$).

A valence x target location interaction was also present, ($F(2,72) = 15.64$, $p < .05$, $\eta_p^2 = .30$), (Figure 13). Negative words were recalled better at T1 (*M* = 7.31, *SD* = 0.95) than T2 (*M* = 5.10, *SD* = 1.80), (t(73) = 13.43, $p < .05$). The same was true for neutral words at T1 (*M* = 7.21, *SD*

= 1.00) and T2 (*M* = 4.93, *SD* = 1.88), (t(73) = 16.15, $p < .05$). Positive words were also recalled more often at T1 (*M* = 6.88, *SD* = 1.20) than T2 (*M* = 5.23, *SD* = 2.05), (t(73) = 11.13, $p < .05$). Positive words at T1 were remembered less often than negative words at T1 (t(73) = -4.22, $p < .05$); they were also remembered less than neutral T1 words (*M* = 7.21, *SD* = 1.00), (t(73) = -3.79, $p < .05$). Positive words were remembered significantly more often than neutral T2 words, (t(73) = 2.32, $p < .05$).

An interaction of repetition and target location was discovered, ($F(1,73) = 29.73$, $p < .05$, $\eta_p^2 = .29$), (see Figure 14). Unrepeated T1 words (*M* = 6.93, *SD* = 1.03) were remembered less often than repeated T1 words (*M* = 7.34, *SD* = 0.99), (t(73) = -0.04, $p < .05$). Conversely, unrepeated T2 words (*M* = 5.22, *SD* = 1.84) were remembered better than repeated T2 words (*M* = 4.94, *SD* = 1.97), (t(73) = 5.23, $p < .05$).

Finally, there was a interaction between valence, repetition, and target location, ($F(2,72) = 21.33$, $p < .05$, $\eta_p^2 = .37$), (Figure 15). For T1, positive repeated words (*M* = 7.24, *SD* = 1.14) were recalled more often than positive unrepeated words (*M* = 6.51, *SD* = 1.26), (t(73) = 4.59, $p < .05$); negative repeated T1 words (*M* = 7.61, *SD* = 0.79) were also recalled more often than negative unrepeated T1 words (*M* = 7.01, *SD* = 0.87), (t(73) = 5.23, $p < .05$). There was no difference in recall of neutral repeated words (*M* = 7.16, *SD* = 1.03) and neutral unrepeated words (*M* = 7.26, *SD* = 0.97) at T1, (t(73) = -0.74, $p > .05$). At T2, positive repeated words (*M* = 5.76, *SD* = 2.07) were actually remembered better than positive unrepeated words (*M* = 4.69, *SD* = 2.02), (t(73) = 5.60, $p < .05$). Negative unrepeated T2 words (*M* = 5.58, *SD* = 1.65) were recalled more often than negative repeated T2 words (*M* = 4.61, *SD* = 1.92), (t(73) = -5.55, $p < .05$); neutral unrepeated T2 words (*M* = 5.39, *SD* = 1.84) were also recalled more often than neutral repeated T2 words (*M* = 4.46, *SD* = 1.92), (t(73) = -4.53, $p < .05$).

Exploratory (Post-hoc) Analyses

It also seemed prudent to examine word recall for the entire sentence, not just the target word, to explore how target words may have impacted overall sentence recall. To do so, the number of words per sentence that each participant correctly recalled was counted, then converted to a percentage of the total sentence. These percentages were then averaged by valence type to explore any differences in word recall across these groups. This analysis was influenced in part by the broaden-and-build theory, which posits that negative emotions tend to narrow individuals' thoughts and actions by evoking specific tendencies (e.g. fleeing, fighting, or freezing), while positive emotions broaden the scope of attention by expanding the ranges of individuals' thoughts and actions (e.g. by playing, exploring, etc) (Frederickson & Branigan, 2005). Based on this, we decided to run an analysis of full sentence recall since broaden-and-build would suggest that the context of the target words would impact recall. A one-way ANOVA was run to compare negative, positive, and neutral furniture and neutral appliance words. Interestingly, no significant differences were discovered between the percentage of recall of positive, negative, and neutral sentences, ($F(3, 292) = .70$, $p > .05$). We failed to support any distinction in participants' attention levels towards sentences featuring negative and positive emotion words.

In the current study, participants completed the positive trials first and the negative trials second, as experimental evidence has shown that negative emotional stimuli can cause a delay in responding to subsequent positive stimuli (Trippe et al., 2007). We wanted to examine how the neutral trials in the positive and negative trials were processed. Post-hoc analyses, in the form of independent samples t-tests, revealed that the first block of neutral words (household appliances) paired with the positive words were recalled significantly more often than the neutral words (furniture) paired with the negative words used in the second block. Superior recall of the first block of neutral words held true across the repeated trials ($t(146, 107.58) = 10.67$, $p < .05$), the unrepeated trials ($t(146, 110.34) = 7.71$, $p < .05$), and the combined trials, which included both repeated and unrepeated sentences ($t(146, 107.58) = 10.67$, $p < .05$). However, as there were no differences in overall recall between sentences featuring positive and negative target words, it does not seem as though practice or fatigue likely account for the decreased performance in the neutral furniture words (the ones presented with the negative trial block). Instead, it seems as though the increased attentional demand of negative words puts a strain on the processing of subsequent neutral trials (McKenna & Sharma, 1995). According to work by McKenna and Sharma (1995), when positive, negative, and neutral words were used as stimuli in an emotional Stroop task, interference occurred only for the negative words. It is also possible that an emotional lingering effect can account for participants missing more of the neutral trials in the negative block. McKenna (1986) found that negative trials impact how subsequent stimuli are processed. Since the negative trials in this study outnumber the neutral trials by a 2:1 ratio, it could be that the large proportion of negative trials leads to high levels of interference, making it difficult to disengage attention from the negative stimuli in time to view and process the following neutral trials.

Discussion

We intended to use the STAI (Spielberger et al., 1983) and BDI-II (Beck et al., 1996) as exclusionary criteria. It was predetermined that participants with scores above 42 on the STAI and/or 13 on the BDI would be excluded from the study; however, due to an unexpectedly high percentage of participants scoring above the cutoffs (47.3%), it was deemed necessary to use their data and include BDI and STAI scores in the analyses. The pair data analyses revealed no main effects of symptomatology when assessed both by types of symptoms present (e.g. whether participants scored highly on the BDI (*N* = 12), the STAI (*N* = 9), both (*N* = 14), or neither (*N* = 39)) and as a binary diagnosis (whether or not participants scored highly on one or both of the mood measures). In addition, symptomatology did not interact with any other factors examined. This was somewhat surprising, as previous studies have indicated that those with anxiety and depressive disorders process negative stimuli differently than those without these disorders. Specifically, previous research has indicated that those with anxiety and/or depressive disorders take longer to process and respond to negative stimuli than those without anxiety and/or depression (e.g., Arend & Botella, 2002; Fox, Russo, & Georgiou, 2005; Trippe et al., 2007).

It is important to note that the majority of these studies examined emotional stimuli in different ways than the current task, so perhaps these methodological differences help to explain why we found no significant differences in performance between participants scoring highly or not on the mood measures. Our task was memory-based and performance was quantified in recall, while research arguing differences in processing between those with and without anxiety and depressive disorders mainly looked at processing speed or response times as the dependent variables. Fox et al. (2005) used an attentional blink (AB) paradigm. They found that high anxiety participants had significantly reduced AB to negative facial expressions as compared to participants without high anxiety. This study was conducted with pictures of facial expressions, not emotion words, so their results may not generalize well to this study. Trippe et al. (2007) used RSVP paradigms and found that spider phobics noticed pictures of spiders more often than non-spider phobic participants, meaning AB was reduced for these negative stimuli. As mentioned, this study utilized pictures of spiders, which are very different from emotion words in full-sentences. Specifically, words and pictures are difficult to compare because they have different emotional associations. Whereas a picture of a tiger or spider may cause an initial reaction because these associations are instinctual, emotional associations to words are learned (Kulke, Bayer, Grimm, & Schacht, 2019). Trippe et al. (2007) also used stimuli specific to phobias, and not general negative emotion, like the current study. Future work could examine phobia specific words in a RSVP paradigm. Arend and Botella (2002) used emotion words in an RSVP-AB paradigm, utilizing a string of eight unrelated 4-6 letter words within an RSVP paradigm. Their findings revealed that negative words reduced the magnitude of AB, but only for the high-trait anxiety group. However, it appears that the authors mixed emotion-laden and emotion-label words (they cited “thief” as an example of an emotion word), and the current study utilizes emotion-label words only. It must also be noted that Arend and Botella’s study was conducted in Spain; it is likely that Spanish emotion words have different valence and arousal values, than English emotion words. Additionally, Spanish emotion words often have two or more words with similar, but nuanced, meanings for one English word, presenting additional difficulties in generalizing between English and Spanish emotion words (van Zyl & Meiselman, 2015).

In the present study, the BDI and STAI were used to assess symptomatology of anxiety and depression—they were not definitive measures of whether participants had anxiety and/or depressive disorders. In contrast, Arend and Botella (2002) and Fox et al. used participants clinically diagnosed with anxiety, whereas Trippe et al. (2007) recruited those diagnosed with phobias. The current study also assessed whether participants had been taking any psychotropic medications. Participants who indicated that they were taking such medications (N = 5) had been stabilized for three or more months. These reasons may help to explain why symptomatology was not significant in either of the current analyses, even though prior research has found that symptomatology affects how negative words are processed.

Overlapping Target Location and Pair Analysis Findings

There was a significant main effect of repetition, such that repeated words were recalled more than unrepeated words overall in both the pair data analysis and the target location analysis. This finding was unexpected. According to the RB hypothesis, repeated words should be recalled more poorly due to the expected failure to token individuate repeated words presented closely in time (Potter et al., 1993). A failure to token individuate means that the two identical type nodes for the repeated words would be linked to the same token node, mentally representing one instance in time (Kanwisher, 1987). On the other hand, being shown unrepeated words would more easily create two distinct token and type nodes, with one type and one token node linked per word. Therefore, it seems as though unrepeated words should be recalled at a higher rate. This main effect seems to be driven by the superior recall of repeated positive words. Stimuli typically used in RB tasks range from unrelated words to complex nonsense shapes, digits and letters, simple shapes and colors, and pictures (Neill et al, 2002). Very few studies with RB focus on/include emotion words (e.g. Anderson, 2005; Keil & Ihssen, 2004; Kanwisher, 1987), and of these, it is difficult to find studies that directly compare positive and negative emotion words with neutral words. The vast majority of studies on this topic intermix emotion-laden and emotion-label words and/or exclude at least one word type. Even the study by Knickerbocker and Altarriba (2013), which the current study partially replicates, did not include positive words; therefore, it is not unsurprising to find that positive emotion words can manipulate attentional resources differently than other types of words, including negative emotion words. This main effect is qualified by various interactions to be discussed below.

The interaction of repetition and valence in both pair and target location analyses suggests that RB effects can be impacted by valence. Negative unrepeated words were better recalled than negative repeated words; this is the standard RB effect found in the literature. The findings for the negative words fit well with the RB effect; failure to token individuate on negative repeated trials could be due to negative words taking more time to disengage our attention (Horstmann et al., 2007). This increased demand could place too much strain upon the attentional resources, causing only one token node to be formed, leading to increased rates of RB (Abrams et al., 1996; Estes & Adelman, 2008). In turn, this is consistent with categorical negativity's tenet that negative words draw our attention involuntarily (Juslin & Laukka, 2003), thus impacting token individuation. The effects for the negative words replicate those of Knickerbocker and Altarriba (2013), and the effects for the positive words expand upon their findings and provide a novel contribution to the literature.

Positive words were recalled better with repetition. This could potentially be due to priming effects, as some ERP evidence has suggested that positive emotion words can facilitate affective priming compared to negative and neutral words due to their higher rates of concreteness (Yao & Wang, 2014). Concreteness is defined as a processing advantage belonging to words that are more material and tangible (e.g. “ bed” or “store”) than abstract (e.g. “freedom” or “liberty”) (Altarriba & Bauer, 2004). Yao and Wang (2014) discovered that when participants were presented with two positive emotion words in a lexical decision task, reaction times to the second positive word were faster than when subjects were shown two negative or two neutral words. This phenomenon is called affective priming (Murphy & Zajonc, 1993). Yao and Wang (2014) suggest that this may be due to the fact that the positive words in the study had higher levels of concreteness than the neutral or negative words, allowing them to be more easily remembered. The current study did not control for concreteness values (see page 49 for a discussion of future work that could examine concreteness in the current task).

Pair and target location analyses both revealed a significant interaction of valence and arousal. This interaction indicated that arousal only impacted the recall of positive words. There was no difference in performance on word recall if negative words were high or low in arousal, but positive words high in arousal were remembered more often than positive low arousal words. One potential reason for this is that the raised arousal levels could result in positive words being initially processed like negative words. As argued by Robinson, Storbeck, Meier, and Kirkeby (2004), “from a decision-making perspective, people are generally better off assuming that arousing stimuli are negative until they can determine otherwise” (p. 1482). Evolutionarily, not responding fast enough to a threat (potentially resulting in death) is worth the relative cost of reacting more slowly towards a reward (Robinson et al., 2004). As such, negative stimuli produce an avoidance response, while positive stimuli typically produce an approach response. Positive high arousal stimuli produce a conflicting response; you want to approach because they are positive, but avoid because they are potentially negative given their high arousal value, resulting in the conflicting approach-avoid response.

While no studies to date have explored both the arousal hypothesis and categorical negativity theory within the context of full-sentence reading, there is a body of experimental evidence to suggest both valence and arousal interact (e.g. Estes & Adelman, 2008; Fernandes et al., 2011; Larsen et al., 2008). The effects of arousal on positively valenced words partially support the arousal hypothesis, as higher arousal words are recalled better (e.g., Juslin & Laukka, 2003). However, the lack of difference in negative word performance supports categorical negativity theory. This is an instance of automatic vigilance, where all negative words receive roughly equal amounts of attention (Juslin & Laukka, 2003). The effects of arousal are not the same for positive and negative words, and any model of word perception and recognition should incorporate both dimensions of emotion to fully account for the findings in the literature.

Overlapping Findings of Analyses with Neutral Words

A valence and repetition interaction was discovered for both pair and target location data when neutral words were included in the analysis. With target location data, positive emotion words were better recalled when repeated, while neutral and negative words had better recall when unrepeated. The results for neutral words and negative words here were as expected, but the superior recall of positive emotion words in the repeated condition was surprising, as it is inconsistent with RB. However, emotion effects could be a possible source of this. It could be possible that these emotional enhancement effects interfere with the typical token individuation process, resulting in better recall for positive emotion words when repeated.

Several studies (e.g. Doerksen & Shimamura, 2001; Kensinger & Corkin, 2003; Rubin & Friendly, 1986; D'Argembeau & Van der Linden, 2004) provide experimental support for the idea of an emotional enhancement effect, such that emotional material is typically better recalled than neutral material because it is partially processed in the basolateral amygdala, increasing its consolidation in the hippocampus (Sommer et al., 2008). Rubin and Friendly (1986) found that emotionality is a major predictor of which words will be recalled in a free recall task—words higher in emotionality were likely to be recalled more often than non-emotional words in a free recall task. Emotion also enhances the vividness of participants' memories, due to their high automatic capture of attention, leading to increased processing and elaboration in longer-term memory (Kensinger & Corkin, 2003). In the current study, only positive emotional stimuli appeared to benefit from the emotional enhancement effect in the pair data analyses. When performance on neutral words was included in the pair analyses, a valence by repetition interaction was revealed, such that neutral words and negative words were treated similarly while positive emotion words were the outliers. There is some experimental evidence in the literature to suggest superior recall of positive information compared to negative information. D'Argembeau and Van der Linden (2004) had participants to try to mentally "re-experience" past negative or positive events, before asking them a series of follow up questions about the experience. They found that participants typically reported more sensorial and factual details, as well as overall stronger feelings of re-experiencing, with positive events compared to negative events. As the authors point out, most people tend to think more frequently about positive events, and this may encourage “the elaboration of positive rather than negative self-relevant information, thus making positive information to be better encoded in memory” (D’Argembeau & Van der Linden, 2004, p. 17).Perhaps the same phenomenon was at play here, such that a bias towards increased elaboration of positive words resulted in enhanced recall in the repeated condition.

Overall, this analysis revealed that positive words do not exhibit typical RB effects, as they actually benefit from repetition. This could be due to the token individuation account, where it is potentially easier to token individuate between two repeated positive word type nodes than any other repeated type nodes. Since positive words benefit from being repeated, repetition may have allocated them more attention than other types of words, meaning ample resources were available to create two distinct type/token nodes. Priming effects could also be responsible here. It could be the case that positive emotion words are more easily primed when repeated in sentences than other types of words. For example, using a priming task, Kazanas and Altarriba (2016) discovered overall faster reaction times to primed positive emotion words than negative emotion words, meaning that they were processed more quickly. This could be a potential explanation for the increased performance in the positive repeated word condition, as increased processing speed likely matters to a time-sensitive task such as the RSVP paradigm.

Findings Unique to Pair Analysis

There was a significant interaction between repetition and arousal, where arousal only appeared to impact the recall of unrepeated words. In the unrepeated condition, high arousal words were recalled more often than low arousal words. This finding is interesting, as superior performance on high arousal unrepeated words is aligned with the idea that high arousal stimuli automatically capture attention resulting in superior recall (e.g. Anderson, 2005; Keil & Ihssen, 2004). One potential explanation for the findings in the repeated condition is that RB effects could potentially account for task performance; RB may have impacted both high and low arousal repeated words equally, while the arousal disproportionately affected unrepeated words. While it is not exactly known why this occurred, one possibility is that since unrepeated words are less susceptible to RB effects (Kanwisher, 1987), they are free from the associated token individuation difficulties; therefore, as they are processed and recalled more “typically,” they could be subject to the influence of arousal with the high arousal words capturing more attention.

Findings Unique to Target Location Data

When target location (examining recall of T1 and T2 recall separately) was examined, there was a main effect of arousal, such that high arousal words were recalled better than low arousal words. This is unsurprising, and fits with the arousal hypothesis overall (Anderson & Phelps, 2001); however, it is important to note that arousal also interacted with other variables. Arousal and target location interacted, such that high arousal words located at T1 were better remembered than low arousal T1 words. There was no difference between high and low arousal words at T2. This seems to agree with the arousal hypothesis, but only partially, at the T1 position. Again, as with the valence and target location interaction, RB effects could potentially be interfering at T2, resulting in no significant differences in recall despite arousal.

Repetition and target location also significantly interacted with one another. Repetition had an impact on words located at T1, but not T2. Repeated T1 words were recalled significantly more often than unrepeated T1 words, where T2 repeated and unrepeated words were recalled at roughly equal rates. It again seems possible that RB effects could be causing interference at T2, resulting in no difference in recall between repeated and unrepeated words. Unrepeated words were similar to each other in terms of their valence and arousal level; therefore, RB effects can still be obtained even though the words are different (Kanwisher, 1987). For example, in the sentence “I felt distressed when my enraged stepdad tried to punish me,” the targets ‘distressed’ and ‘enraged’ are two separate words, but they are nearly identical in their valence and arousal values, perhaps contributing to RB effects.

A main effect of target location was also present; words at T1 were better remembered than words at T2. This finding fits nicely with the idea of RB, where attention is so engaged with the first target word, that it is difficult to disengage and notice the second instance of a word (Kanwisher, 1987). There was also an interaction of target location and valence. Negative T1 words were recalled more often than positive T1 words, and there was no significant difference between positive and negative T2s. This is partially supportive of categorical negativity theory, as negative words appeared to be slightly favored during recall. Perhaps this effect only appears at the T1 location because these words are not as susceptible to RB effects (Kanwisher, 1987), which could potentially be the reason there is not a significant difference in recall for positive and negative T2 words. However, as there is also a significant three-way interaction looking at valence and target location with repetition. It is likely that this interaction is better explained with the addition of repetition, so this finding on its own is not very meaningful.

An interaction between repetition and target location was present. Overall, repeated T1 words were recalled better than unrepeated T1 words. This was as expected, as repeating words would make it more likely that at least one instance of the word would be token individuated in memory, meaning a higher chance of recall. Conversely, unrepeated T2 words were recalled better than repeated T2 words. This is also as expected; the individuality of a T2 word in the unrepeated conditions likely makes it easier to token individuate between two different instances of two different words, making RB less likely (Potter et al., 1993).

Also discovered was an interaction of valence, repetition, and target location (this finding was also significant when neutral words were included, which will be discussed in the next section). At T1, positive repeated words were recalled more often than positive unrepeated words, and negative repeated T1 words were also better remembered than negative unrepeated T1 words. On the other hand, positive repeated T2 words were better recalled than positive unrepeated T2 words, but negative repeated T2 words were not recalled as well as negative unrepeated T2 words. Regardless of location, positive words always benefitted from repetition. Interestingly, at T1, repetition seemed to have a detrimental impact on negative words. The findings for negative words at T2 are as expected, as this is the standard RB effect (Neill et al., 2002). However, the findings for positive words are interesting, as regardless of target location, positive words were remembered better if repeated. This seems to tie into the idea raised with the pair data analysis, where it could be possible that emotional enhancement effects could only have a beneficial effect on positive emotion words (D’Argembeau & Van der Linden, 2004). D’Argembeau and Van der Linden (2004) had participants to try to mentally “re-experience” past negative or positive events, and found that participants typically reported more sensorial and factual details, as well as overall stronger feelings of re-experiencing, with positive events compared to negative events. Perhaps the same phenomenon was at play here, such that a bias towards positive stimuli resulted in better recall.

Findings Unique to Target Location Data with Neutral Words

When neutral data was analyzed alongside positive and negative words with target location and repetition, a main effect of target location was discovered. T1 words were better remembered than T2 words; again, this aligns with RB, where attention is so engaged with the first target, that the second is more likely to be missed (Kanwisher, 1987).

An interaction between repetition and target location was present. Overall, repeated T1 words were recalled better than unrepeated T1 words. This was as expected, as repeating words would make it more likely that at least one instance of the word would be token individuated in memory, meaning a higher chance of recall. Conversely, unrepeated T2 words were recalled better than repeated T2 words. This is also as expected; the individuality of a T2 word in the unrepeated conditions likely makes it easier to token individuate between two different instances of two different words, making RB less likely (Potter et al., 1993).

The three-way interaction of valence, repetition, and target location remained significant with the inclusion of neutral words. Overall, repetition benefitted positive words regardless of target location, while negative words were hurt by repetition, but only at T2. It seems as though negative word recall was in line with the typical RB effects, as it suffered in performance as a result of being repeated, particularly at the second target. This indicates that the processing of negative T1 words captured too many attentional resources in order for a timely direction to the repeated negative T2 word (Kanwisher, 1987). As the processing of unrepeated words at T2 did not suffer, it can be concluded that standard RB effects are prominent in the negative words. This replicates the negative word findings of Knickerbocker and Altarriba (2013), who used 18 negative emotion-laden, 18 negative emotion-label, and 18 neutral words. However, positive words are again outliers here. This interaction is interesting, and seems to reflect an emotional memory enhancement effect. Again, it appears as though this emotional memory effect impacts emotion words differently depending on valence (D'Argembeau & Van der Linden, 2004). Whereas negative emotion words typically were recalled on par with, or slightly more often, than neutral words, positive words experienced superior recall.

Valence and target location also interacted, such that negative words were the best recalled of any T1 words and positive words were the most poorly recalled. At T2, negative and positive words were recalled at similar rates, and more often than neutral words. The enhanced performance of emotion words at T2 again seems to tie into emotional memory enhancement, as emotion words were better recalled than neutral words (Rubin & Friendly, 1986). Interestingly, this idea of an emotional memory enhancement effect only remains true for T2 words here. This is surprising, as positive words show a detriment at T1 while most other results point to increased positive word recall. For one, priming effects could be at play here. Positive words seem to need repetition to be recalled well, for some unknown reason, as seen by the poor T1 recall and improved T2 recall. It is also likely that this interaction is qualified by the significant three-way interaction of valence, target location, and repetition, and, as such, this interaction tells an incomplete story. In light of the three-way interaction, this interaction likely is not as meaningful, as including repetition means a more complete picture of the data is gained.

While looking for evidence to help explain and contextualize the results of this study (namely, why positive words were remembered better overall), work by Yao and Wang (2014) was discovered. Positive words were also recalled more often in their ERP study, and the authors partially explained this finding as a function of the positive words in the study having higher levels of concreteness than the negative and neutral words. As the word characteristics controlled for in emotion word literature are typically word length and frequency, these were included in the current study, but concreteness was not examined in the initial analyses. Post-hoc, we examined the concreteness levels of the positive, negative, and neutral target words included in the study with concreteness values determined by the English Lexicon Project (ELP; Balota et al., 2007). It is important to note that three of the positive target words used in the study were not found in the ELP database. However, based on the rest of the target words, it appears that there are no significant differences in concreteness between positive and negative emotion words, ($F(43, 41.3) = .81$, $p > .05$). There are significant differences in concreteness between the emotion words and the neutral words. This is as expected; as neutral words are not emotional in nature, this means they should be higher in concreteness. Neutral words were split into two groups based on their theme (either appliances or furniture) and order (appliance words were shown first). According to Tukey post-hoc comparisons, neutral appliance words ($M = 4.81$, $SD = 0.20$) were more concrete than negative low arousal words ($M = 2.45$, $SD = 0.52$), negative high arousal words ($M = 2.49$, $SD = 0.31$), positive low arousal words ($M = 2.26$, $SD = 0.60$), and positive high arousal words ($M = 2.34$, $SD = 0.21$). Post-hoc Tukey HSD tests also revealed the neutral furniture words ($M = 4.82$, $SD = 0.12$) were significantly more concrete than negative low arousal ($M = 2.45$, $SD = 0.52$), negative high arousal ($M = 2.49$, $SD = 0.31$), positive low arousal ($M = 2.26$, $SD = 0.60$), and positive high arousal conditions ($M = 2.34$, $SD = 0.21$). There were no significant differences between the neutral appliance and neutral furniture words. Overall, this means that the neutral words were much higher in concreteness ratings than any of the emotion word categories, and that concreteness cannot account for the differences in recall between the positive and negative words in the current study.

Limitations

One obvious limitation is the limited sample in this study. This was convenience sampling; participants were all college-aged, in introductory psychology courses at the same large private research university. There is evidence to suggest that overall, attentional capabilities remain largely similar across all age ranges, with only a slight decline towards the end of adulthood, so the findings from college students should be fairly applicable to other age groups (Laver & Burke, 1993). However, further research should aim to include a more diverse age range. Potential future work examining age and attention to emotional information will be discussed in the Future Directions section below.

Another limitation of this study is the applicability of the RSVP task to everyday life. In reality, we do not typically read at a speed of 10-12 words per second (3-5 words per second is typical), nor do we spend equal amounts of time on each word we see. Full sentences were included to somewhat mitigate the generalizability, as RSVP typically presents unrelated target strings; however, it is still different from the way reading is usually conducted outside of an experimental setting. Therefore, the results of this study may not generalize well to everyday reading, but are a better reflection of this process than the majority of the research that examines reading single words in isolation. This is a step in the right direction, but future work could be done with a natural reading study with eye-tracking measures. Fox example, Scott, O'Donnell, and Sereno (2012) explored positive, negative, and neutral high- and low-frequency words within the context of natural reading. Participants were fitted with eye-tracking devices, designed to analyze where and for how long the eyes were fixated, before reading neutral sentence frames containing neutral, negative, and positive emotion words. Their results indicate that fixation times on emotion words were typically faster than fixation times for neutral words, suggesting that we attend to emotional stimuli more automatically and quickly than neutral stimuli. Knickerbocker, Johnson, and Altarriba (2015) used eye tracking to analyze how words of different valence and arousal levels are read and processed within a neutral sentence framework, using a similar process to Scott et al. (2012). Knickerbocker et al. (2015) found that words high in valence and arousal were processed more quickly and easily than neutral words. Together, these studies indicate that examining valence and arousal within the framework of neutral sentences would be worthwhile.

Additionally, another limitation seems to be the English language itself. Choosing word stimuli was a bit difficult, as there is a quite finite quantity of emotion words to choose from, and an even slimmer number of these fit the criteria of being low-arousal emotion words. Finding emotion words to fit the predefined levels of valence and arousal, while also ensuring they could be used in meaningful sentences, was a challenge due to the limited number of words. As a result, the potential for replication with different emotion words seems unlikely, as there are simply not many other emotion words not used in this study that would fit the criteria for valence and arousal constraints. Moving forward, as arousal does not need to be taken into account with negative words, researchers should have an easier task finding stimuli—as negative words do not need to be further constrained by arousal, there will hopefully be more words to pick from.

Future Directions

In future studies, using imaging tasks such as ERP or fMRI may help delineate our unexpected finding of better recall for positive words. Perhaps there is some mechanism responsible for the processing differences between repeated positive and negative words. Additionally, using imaging while asking participants to view and recall high and low arousal positive words could help to provide more clarity as to whether the findings in this study are driven more by arousal or valence. Particularly, in line with the study by Bayer et al. (2010), using ERP to examine how sentences with both valence and arousal affect the late positive complex (LPC) would be prudent. Bayer et al. (2010) used negative and neutral words varying in arousal and concluded that negative, high arousal words elicited the largest LPC, suggesting valence and and arousal modulated it; however, when negative valence was held constant and only arousal was manipulated, the LPC remained equally large. Their results emphasize the role of valence, but positively valenced words were not included in their work. Future studies should examine how positive words varying in arousal impact the LPC, as the current study suggests that positive high arousal words are treated differently than positive low arousal words.

As this study exclusively examined emotion-label words, perhaps future research could also include emotion-laden words. Research has shown that emotion-laden and emotion-label are processed differently within the brain (e.g., Altarriba & Basnight-Brown, 2011; Knickerbocker & Altarriba, 2013; Zhang, Wu, Meng, & Yuan, 2017). In an ERP study, Zhang et al. (2017) discovered that emotion-laden and emotion-label words elicited different cortical responses across multiple areas of the brain. Thus, to get a full picture of emotional words and how they influence attention, this would make an excellent follow-up. Using RSVP, Knickerbocker and Altarriba (2013) examined negative emotion-laden and emotion-label words in an RSVP paradigm. Their findings revealed that the negative emotion-label words consistently produced larger RB effects than the negative emotion-laden words. Altarriba and Basnight-Brown (2011) used the Affective Simon Task, which is a task designed to measure automatic word processing where participants are presented with a series of words and asked to attend to whether the word is a noun or an adjective. Using the Affective Simon Task to explore both positive and negative emotion-laden and emotion-label words, it was discovered that while participants displayed standard Simon effects for negative emotion-label words only, both positive and negative emotion-laden words produced significant congruency effects (Altarriba & Basnight-Brown, 2011, p. 322). However, neither of these studies included arousal, and Knickerbocker and Altarriba (2013) only looked at words with negative valence, so there is much room for future research with arousal and emotion-laden words.

As mentioned, it would also be beneficial for further research to replicate this outside of a college-aged sample. It seems worthwhile to examine how older populations respond to the task; although studies argue that processing tends to remain similar across age ranges, with only a slight decline in older adulthood, there are no studies to suggest older and younger adults respond similarly to RSVP tasks. The quick, constrained viewing times of each item in the RSVP string seems as though it may be more challenging for anyone with slightly reduced processing speed. Additionally, there is research indicating that older individuals tend to experience a positivity effect, while younger adults tend to focus on negative stimuli more often (Mather & Carstensen, 2005; Mroczek & Kolarz, 1998). This positivity effect results in older adults thinking more often about positive events and experiencing fewer negative emotions overall. As such, this positivity effect could potentially influence how negative and positive high and low arousal stimuli are processed in an older population. It is possible that positive words would be processed more quickly or remembered even better by older individuals using the current task.

Finally, future work could distinguish emotional words further on the basis of threat. As work has demonstrated that negative stimuli can be given additional priority when the stimulus is threat-based (e.g. a word like “angry” will be given attentional priority over a non-threating negative stimulus like “sad”) (McKenna & Sharma, 1995). This attentional priority results in an emotional lingering effect, such that threatening information automatically captures attention more quickly than non-threatening information, leading to slower response times on tasks such as the emotional Stroop paradigm (McKenna, 1986). Together, these works indicate that future research could benefit by exploring differences between threatening and non-threatening emotion words. As research with visual search tasks suggests threatening stimuli produce heightened arousal and attention levels compared to non-threatening stimuli (e.g. Becker, 2009; Phelps & LeDoux, 2005), perhaps faster response times for non-threatening negative stimuli would be observed as a function of being a distinct, less arousing category from threatening emotional stimuli.

Applications

If negative words are repeated in a sentence closely in time, the second instance is often missed; if positive words are repeated, they are remembered better. This means that, depending on the valence of the repeated word, repeating it can either enhance or harm recall. These outcomes could potentially influence reading comprehension. While this may not usually matter much in everyday life, one area where the valence and repetition of a word could particularly have an undue influence is mood measures. The findings of this work suggest that mood measures could improve by replacing instances of repeated negative and positive words with two separate, unrepeated words in order not to bias attention and, ultimately comprehension on something designed to assess for positive and/or negative mood symptomatology.

In this vein, another potential application could be using this work to train artificial intelligence (AI) systems used in clinical applications (e.g. Luxton, 2013). As AI programs have superb capabilities to recognize and process language, this makes them potential tools for clinical applications including patient interviewing and diagnosis. Thus, it could be prudent to teach these systems that repeating words, particularly emotion words, can impact the subsequent attention and processing of patients.

There are other therapeutic applications for the current work. One example is motivational interviewing, a type of counseling technique designed to help clients change their behaviors by specifically exploring ambivalent feelings about change and attempting to elicit motivation through talk. In this case, repeating positive emotion words may be useful to clients as it would increase their chances of hearing positive emotion language, which in turn could increase their likelihood to become motivated to change or alter a behavior. Wagner and Ingersoll (2008), in a study examining the role of positive emotions in motivational interviewing, posit that “motivation involves a desire to experience positive emotions” (p. 191); as such, it is important to take note that repeating positive words closely in time may increase the chances that motivational interviewing elicits positive emotions such as hope and contentment (Wagner & Ingersoll, 2008).

Additionally, repeating positive words to increase the chances of retention may also prove beneficial in a therapy such as cognitive-behavioral therapy, or CBT. CBT is a goal-oriented treatment that aims to change thought or behavior patterns that are involved in or responsible for clients' difficulties (Leichsenring, Hiller, Weissberg, & Leibing, 2006). By attempting to challenge unhelpful cognitive distortions and thoughts, using repeated positive emotion words could prove beneficial to changing negative thought patterns and replacing them with more beneficial thoughts. Interestingly, there is a specific area of CBT called Positive CBT (Bannink, 2013), which combines positive psychology with CBT to improve quality of life through helping people to feel more capable, able, and focused on their personal strengths. The findings of the current study could apply here, as they suggest repeating positive words and phrases may increase their recall, helping patients change their cognitions to less negative ones.

Conclusions

Overall, this work supports the idea that valence and arousal do interact, as they both play a role in the allotment of attentional resources. As neither the arousal hypothesis nor categorical negativity theory can account for the current data alone, researchers must consider the need for a more cohesive, nuanced theory of attention and emotion that accounts for the interactive nature of valence and arousal. Specifically, this new theory must support the idea that arousal does not impact negative words, but high arousal and low arousal positive words are processed differently. Additionally, this study adds to the body of evidence that positive emotion words are treated differently than negative emotion words and neutral words, as they seem to benefit from repetition. This raises the prospect of an emotional memory enhancement effect, but only for positive emotion words.

References

Abrams, L., Dyer, J. R., & MacKay, D. G. (1996). Repetition blindness interacts with syntactic grouping in rapidly presented sentences. *Psychological Science*, *7*, 100-104. doi:10.1111/j.1467-9280.1996.tb00337.x

Altarriba, J., & Basnight-Brown, D. M. (2011). The representation of emotion vs. emotion-laden words in English and Spanish in the Affective Simon Task. *International Journal of Bilingualism*, *15*, 301-328. doi:10.1177/1367006910379261

Altarriba, J., & Bauer, L. M. (2004). The distinctiveness of emotion concepts: A comparison between emotion, abstract, and concrete words. *The American Journal of Psychology*, *117*, 389-410.

Anderson, A. K. (2005). Affective influences on the attentional dynamics supporting awareness. *Journal of Experimental Psychology: General*, *134*, 258-281. doi:10.1037/0096-3445.134.2.258

Anderson, A. K., Christoff, K., Stappen, I., Panitz, D., Ghahremani, D. G., Glover, G., Gabrieli, J. D. E., & Sobel, N. (2003). Dissociated neural representations of intensity and valence in human olfaction. *Nature Neuroscience*, *6*, 196-202. doi: 10.1038/nn1001

Anderson, A. K., & Phelps, E. A. (2001). Lesions of the human amygdala impair enhanced perception of emotionally salient events. *Nature*, *411*, 305-309. doi: 10.1038/35077083

Arend, I., & Botella, J. (2002). Emotional stimuli reduce the attentional blink in sub-clinical anxious subjects. *Psicothema*, *14*, 209-214.

Arnell, K. M., & Shapiro, K. L. (2010). Attentional blink and repetition blindness. *Cognitive Science*, *2*, 336-344. doi:10.1002/wcs.129

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

Bannink, F. P. (2013). Are you ready for positive cognitive behavioral therapy? *The Journal of Happiness and Well-Being*, *2*, 61-69.

Bayer, M., Sommer, W., & Schacht, A. (2010). Reading emotional words within sentences: The impact of arousal and valence on event-related potentials. *International Journal of Psychophysiology*, *78*, 299-307. doi:10.1016/j.ijpsycho.2010.09.004

Beck, A. T., Steer, R. A., & Brown, G. K. (1996). *Manual for the Beck Depression Inventory*. San Antonio, TX: Psychological Corporation.

Becker, M. W. (2009). Panic search: Fear produces efficient visual search for nonthreatening objects. *Psychological Science*, *20*, 435-437.

Bradley, M. M., & Lang, P. J. (1999). *Affective norms for English words (ANEW)*. Gainesville, FL: The NIMH Center for the Study of Emotion and Attention, University of Florida.

Broadbent, D. E., & Broadbent, M. H. (1987). From detection to identification: Response to multiple targets in rapid serial visual presentation. *Perception & Psychophysics*, *42*, 105-113. doi: 10.3758/BF03210498

Brosch, T., Sander, D., Pourtois, G., & Scherer, K. R. (2008). Beyond fear: Rapid spatial orienting toward positive emotional stimuli. *Psychological Science*, *19*, 362-370. doi: 10.1111/j.1467-9280.2008.02094.x

Brosch, T., Scherer, K. R., Grandjean, D., & Sander, D. (2013). The impact of emotion on perception, attention, memory, and decision-making. *Swiss Medical Weekly*, *143*, w13786. doi: 10.4414/smw.2013.13786

Cowan, N. (2005). Selective attention tasks in cognitive research. In A. Wenzel & D. C. Rubin (Eds.), *Cognitive methods in clinical research* (pp.73-96). Washington, DC: American Psychological Association.

D'Argembeau, A., & Van der Linden, M. (2004). Phenomenal characteristics associated with projecting oneself back into the past and forward into the future: Influence of valence and temporal distance. *Consciousness and Cognition*, *13*, 844-858.

Doerksen, S., & Shimamura, A. P. (2001). Source memory enhancement for emotional words. *Emotion*, *1*, 5-11.

Eastwood, J. D., Smilek, D., & Merikle, P. M. (2001). Differential attentional guidance by unattended faces expressing positive and negative emotion. *Perception & Psychophysics*, *63*, 1004-1013. doi:10.3758/BF03194519

Estes, Z., & Adelman, J. S. (2008). Automatic vigilance for negative words in lexical decision and naming: Comment on Larsen, Mercer, and Balota (2006). *Emotion*, *8*, 441-444. doi:10.1037/1528-3542.8.4.441

Fagot, C., & Pashler, H. (1995). Repetition blindness: Perception or memory failure? *Journal of Experimental Psychology: Human Perception and Performance*, *55*, 275-292.

Fernandes, M. A., Koji, S., Dixon, M. J., & Aquino, J. M. (2011). Changing the focus of attention: The interacting effect of valence and arousal. *Visual Cognition*, *19*, 1191-1211. doi: 10.1080/13506285.2011.618151

Fox, E., Russo, R., & Georgiou, G. A. (2005). Anxiety modulates the degree of attentive resources required to process emotional faces. *Cognitive, Affective, and Behavioral Neuroscience*, *5*, 396-404.

Frederickson, B. L., & Branigan, C. (2005). Positive emotions broaden the scope of attention and thought-action repertoires. *Cognition and Emotion*, *19*, 313-332.

Frijda, N. H. (1988). The laws of emotion. *American Psychologist*, *43*, 349-358. doi: 10.1037/0003-066X.43.5.349

Frischen, A., Eastwood, J. D., & Smilek, D. (2008). Visual search for faces with emotional expressions. *Psychological Bulletin*, *134*, 662-676. doi:10.1037/0033-2909.134.5.662

Gerritsen, C., Frischen, A., Smilek, D., Blake, A., & Eastwood, J. D. (2007). Visual search for emotional faces is not blind to emotion. *Journal of Vision*, *7*, 1055-1068. doi:10.1167/7.9.1068.

Holt, D. J., Lynn, S. K., & Kuperberg, G. R. (2009). Neurophysiological correlates of comprehending emotional meaning in context. *Journal of Cognitive Neuroscience*, *21*, 2245-2262. doi: 10.1162/jocn.2008.21151

Horstmann, G., Scharlau, I., & Ansorge, U. (2007). More efficient rejection of happy than angry face distractors in visual search. *Psychonomic Bulletin & Review*, *13*, 1067-1073. doi:10.3758/BF03213927

Juslin, P. N., & Laukka, P. (2003). Communications in vocal expression and music performance: Different channels, same code? *Psychological Bulletin*, *129*, 770-814. doi:10.1037/0033-2909.129.5.770

Juth, P., Karlsson, A., Lundqvist, D., & Ohman, A. (2000). Finding a face in the crowd: Effects of emotional expression, direction and social anxiety. *International Journal of Psychology*, *35*, 424-434. doi:10.1037/1528-3542.5.4.379

Kanwisher, N. G. (1987). Repetition blindness: Type recognition with token individuation. *Cognition*, *27*, 117-143. doi:10.1016/0010-0277(87)90016-3

Kanwisher, N. G. (1991). Repetition blindness and illusory conjunctions: Errors in binding visual types with visual tokens. *Journal of Experimental Psychology: Human Perception and Performance*, *17*, 404-421.

Kanwisher, N. G. , & Potter, M. C. (1989). Repetition blindness: The effects of stimulus modality and spatial displacement. *Memory & Cognition*, *17*, 117-124.

Kanwisher, N. G., & Potter, M. C. (1990). Repetition blindness: Levels of processing. *Journal of Experimental Psychology: Human Perception and Performance*, *16*, 30-47. doi: 10.1037/0096-1523.16.1.30

Kazanas, S. A., & Altarriba, J. (2016). Emotion word processing: Effects of word type and valence in Spanish-English bilinguals. *Journal of Psycholinguistic Research*, *45*, 395-406.

Keil, A., & Ihssen, N. (2004). Identification facilitation for emotionally arousing verbs during the attentional blink. *Emotion*, *4*, 23-35. doi:10.1037/1528-3542.4.1.23

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

Klinger, E. (1975). Consequences of commitment to and disengagement from incentives. *Psychological Review*, *82*, 1-25. doi: 10.1037/h0076171

Knickerbocker, H., & Altarriba, J. (2013). Differential repetition blindness with emotion and emotion-laden word types. *Visual Cognition*, *5*, 599-627. doi:10.1080/13506285.2013.815297

Knickerbocker, H., Johnson, R. L., & Altarriba, J. (2015). Emotion effects during reading: Influence of an emotion target word on eye movements and processing. *Cognition and Emotion*, *29*, 784-806.

Kulke, L., Bayer, M., Grimm, A., & Schacht, A. (2019). Differential effects of learned associations with words and pseudowords on event-related brain potentials. *Neuropsychologia*, *124*, 182-191.

Lang, P. J. (1980). Behavioral treatment and bio-behavioral assessment: computer applications. In J. B. Sidowski, J. H. Johnson, & T. A. Williams (Eds.), *Technology in mental health care delivery systems* (pp. 119-137). Norwood, NJ; Ablex.

Larsen, R. J., Mercer, K. A., & Balota, D. (2006). Lexical characteristics of words used in emotion Stroop studies. *Emotion*, *6*, 62-72. doi:10.1037/1528-3542.6.1.62

Larsen R. J., Mercer, K. A., Balota, D. A., & Strube, M. J. (2008). Not all negative words slow down lexical decision and naming speed: Importance of word arousal. *Emotion*, *8*, 445-452. doi: 10.1037/1528-3542.8.4.445

Laver, G. D., & Burke, D. M. (1993). Why do semantic priming effects increase in old age? A meta-analysis. *Psychology and Aging*, *8*, 34-43.

Leichsenring, F., Hiller, W., Weissberg, M., & Leibing, E. (2006). Cognitive-behavioral therapy and psychodynamic therapy: Techniques, efficacy, and indications. *American Journal of Psychotherapy*, *60*, 233-259.

Leite, J., Carvalho, S., Galdo-Alvarez, S., Alves, J., Sampaio, A., & Goncalves, O. F. (2012). Affective picture modulation: Valence, arousal, attention allocation and motivational significance. *International Journal of Psychophysiology*, *83*, 375-381. doi: 10.1016/j.ijpsycho.2011.12.005

Luo, C. R., & Caramazza, A. (1995). Repetition blindness under minimum memory load: Effects of spatial and temporal proximity and the encoding effectiveness of the first item. *Perception & Psychophysics*, *57*, 1053-1064.

Luxton, D. D. (2013). Artificial intelligence in psychological practice: Current and future applications and implications. *Professional Psychology: Research and Practice.* Advance online publication.

MacKay, D. G., Hadley, C. B., & Schwartz, J. H. (2005). Relations between emotion, illusory word perception, and orthographic repetition blindness: Tests of binding theory. *Quarterly Journal of Experimental Psychology: Human Experimental Psychology*, *58A*, 1514-1533. doi:10.1080/02724980443000728

Martín-Loeches, M., Fernández, A., Schacht, A., Sommer, W., Casado, P., Jiménez-Ortega, L., & Fondevila, S. (2012). The influence of emotional words on sentence processing: Electrophysiological and behavioral evidence. *Neuropsychologia*, *50*, 3262-3272. doi:10.1016/j.neuropsychologia.2012.09.010

Mather, M., & Carstensen, L. L. (2005). Aging and motivated cognition: The positivity effect in attention and memory. *Trends in Cognitive Sciences*, *9*, 496-502.

McKenna, F. P. (1986). Effects of unattended emotional stimuli on color-naming performance. *Current Psychological Research and Reviews*, *5*, 3-9.

McKenna, F. P., & Sharma, D. (1995). Intrusive cognitions: An investigation of the emotional Stroop task. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *21*, 1595-1607.

Milders, M., Sahraie, A., Logan, S., & Donnellon, N. (2006). Awareness of faces is modulated by their emotional meaning. *Emotion*, *6*, 10-17. doi:10.1037/1528-3542.6.1.10

Most, S. B., & Junge, J. A. (2008). Don't look back: Retroactive, dynamic costs and benefits of emotional capture. *Visual Cognition*, *16*, 262-278. doi:10.1080/13506280701490062

Most, S. B., Smith, S. D., Cooter, A. B., Levy, B. N., & Zald, D. H. (2007). The naked truth: Positive, arousing distractors impair rapid target perception. *Cognition and Emotion*, *21*, 964-981. doi:10.1080/02699930600959340

Mroczek, D. K., & Kolarz, C. M. (1998). The effect of age on positive and negative affect: A developmental perspective on happiness. *Journal of Personality and Social Psychology*, *75*, 1333-1349.

Murphy, S. T., & Zajonc, R. B. (1993). Affect, cognition, and awareness: affective priming with optimal and suboptimal stimulus exposures. *Journal of Personality and Social Psychology*, *64*, 723-739.

Neill, W. T., Neely, J. H., Hutchson, K. A., Kahan, T. A., & VerWys, C. A. (2002). Repetition blindness, forward and backward. *Journal of Experimental Psychology*, *28*, 137-149. doi: 10.1037//0096-1523.28.1.137

Ohman, A., Lundqvist, D., & Esteves, F. (2001). The face in the crowd revisited: A threat advantage with schematic stimuli. *Journal of Personality and Social Psychology*, *80*, 391-396. doi: 10.1037/0022-3514.80.3.381

Petrucci, M., & Pecchinenda, A. (2017). Sparing and impairing: Emotion modulation of the attentional blink and the spread of sparing in a 3-target RSVP task. *Attention, Perception, & Psychophysics*, *80*, 439-452. doi:10.3758/s13414-017-1470-y

Phelps, E. A., & LeDoux, J. E. (2005). Contributions of the amygdala to emotion processing: From animal models to human behavior. *Neuron*, *48*, 175-187.

Pool, E., Brosch, T., Delplanque, S, & Sander, D. (2016). Attentional bias for positive emotional stimuli: A meta-analytic investigation. *Psychological Bulletin*, *142*, 79-106. doi: 10.1037/bul0000026

Potter, M. C. (1984). Rapid serial visual presentation (RSVP): A method for studying language processing. In D. Kieras & M. Just (Eds.), *New methods in reading comprehension research*, (pp. 91-118). Hillsdale, NJ: Erlbaum.

Potter, M. C., Kroll, J. F., Yachtzel, B., Carpenter, E., & Sherman, J. (1986). Pictures in sentences: Understanding without words*. Journal of Experimental Psychology: Genera*l, *115*, 281-294. doi:10.1037/0096-3445.115.3.281

Potter, M. C., Moryadas, A., Abrams, I., & Noel, A. (1993). Word perception and misperception in context. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *19*, 3-22. doi:10.1037/0278-7393.19.1.3

Pourtois, G., Schettino, A., & Vuilleumier, P. (2013). Brain mechanisms for emotional influences on perception and attention: What is magic and what is not*. Biological Psychology*, *92*, 492-512. doi:10.1016/j.biopsycho.2012.02.007

Pratto, F., & John, O. P. (1991). Automatic vigilance: The attention-grabbing power of negative social information*. Journal of Personality and Social Psychology*, *61*, 380-391.

doi:10.1037/0022-3514.61.3.380

Robinson, M. D., Storbeck, J., Meier, B. P., & Kirkeby, B. S. (2004). Watch out! That could be dangerous: Valence-arousal interactions in evaluative processing. *Personality and Social Psychology Bulletin*, *30*, 1142-1484.

Rubin, D. C., & Friendly, M. (1986). Predicting which words get recalled: Measures of free recall, availability, goodness, emotionality, and pronounceability for 925 words. *Memory and Cognition*, *14*, 79-94.

Russell, J. A. (1980). A circumplex model of affect. *Journal of Personality and Social Psychology*, *39*, 1161-1178. doi: 10.1037/h0077714

Sander, D., Grafman, J., & Zalla, T. (2003). The human amygdala: An evolved system for relevance detection. *Reviews in the Neurosciences*, *14*, 303-316. doi: 10.1515/REVNEURO.2003.14.4.303

Schimmack, U. (2005). Attentional interference effects of emotional pictures: Threat, negativity, or arousal? *Emotion*, *5*, 55-66. doi: 10.1037/1528-3542.5.1.55

Scott, G. G., O'Donnell, P. J., & Sereno, S. C. (2012). Emotion words affect eye fixations during reading. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *38*, 783-792.

Silvert, L., Naveteur, J., Honoré, J., Sequeira, H., & Boucart, M. (2004). Emotional stimuli in rapid serial visual presentation. *Visual Cognition*, *11*, 433-460. doi:10.1080/13506280344000239

Sommer, T., Glascher, J., Moritz, S., & Buchel, C. (2008). Emotional enhancement effect of memory: Removing the influence of cognitive factors. *Learning and Memory*, *15*, 569-

573. doi:10.1011/lm.995108

Spielberger, C. D., Gorsuch, R. L., Lushene, R., Vagg, P. R., & Jacobs, G. A. (1983). *Manual for the State-Trait Anxiety Inventory (Form Y).* Palo Alto, CA: Consulting Psychologist.

Sutton, T. M., & Altarriba, J. (2011). The automatic activation and perception of emotion in word processing: Evidence from a modified dot-probe paradigm. *Journal of Cognitive Psychology*, *23*, 736-747. doi:10.1080/20445911.2011.554392

Trippe, R. H., Hewig, J., Heydel, C., Hecht, H., & Miltner, W. H. R. (2007). Attentional blink to emotional and threatening pictures in spider phobics: Electrophysiology and behavior. *Brain Research*, *1148*, 149-160. doi:10.1016/j.brainres.2007.02.035

Van Zyl, H., & Meiselman, H. L. (2015). The roles of culture and language in designing emotion lists: Comparing the same language in different English and Spanish speaking countries. *Food Quality and Preference*, *41*, 201-213.

Vogt, J., De Houwer, J., Koster, E. H. W., Van Damme, S., & Crombez, (2008). Allocation of spatial attention to emotional stimuli depends upon arousal and not valence. *Emotion*, *8*, 880-885. doi: 10.1037/a0013981

Wagner, C. C. , & Ingersoll, K. S. (2008). Beyond cognition: Broadening the emotional base of motivational interviewing. *Journal of Psychotherapy Integration*, *18*, 191-206.

Wentura, D., Rothermund, K., & Bak, P. (2000). Automatic vigilance: The attention-grabbing power of approach- and avoidance-related social information. *Journal of Personality and Social Psychology*, *78*, 1024-1037. doi:10.1037/0022-3514.78.6.1024

Whittlesea, B.. W., Dorken, M. D., & Podruzek, K. W. (1995). Repeated events in rapid lists: I. Encoding and representation. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *21*, 1670-1688.

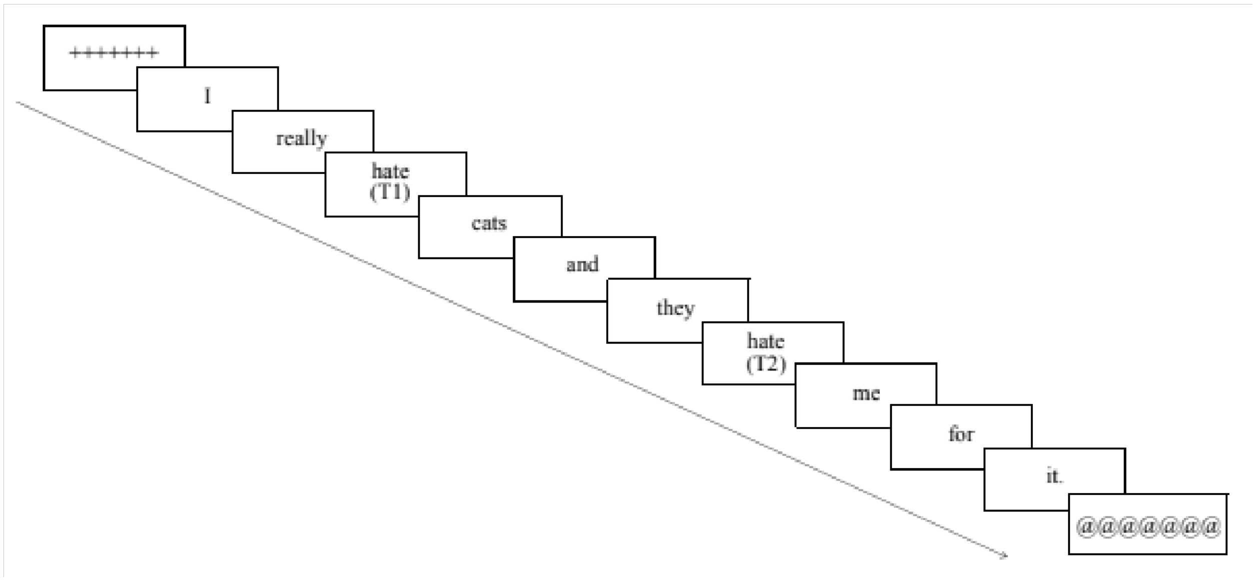
Yiend, J. (2010). The effects of emotion on attention: A review of attentional processing of emotional information. *Cognition and Emotion*, *24*, 3-47. doi:10.1080/02699930903205698

Yao, Z., & Wang, Z. (2014). Concreteness of positive word contributions to affective priming: An ERP study. *International Journal of Psychophysiology*, *93*, 275-282.

Zhang, J., Wu, C., Meng, Y., & Yuan, Z. (2017). Different neural correlates of emotion-label words and emotion-laden words: An ERP study. *Frontiers in Human Neuroscience*, *11*, 455. doi:10.3389/fnhum.2017.00455

Figure 1

Example RSVP Sentence Stream



Note. T1 and T2 labels on the figure were not shown to participants.

Figure 2

Interaction of Valence and Repetition with Pair Data

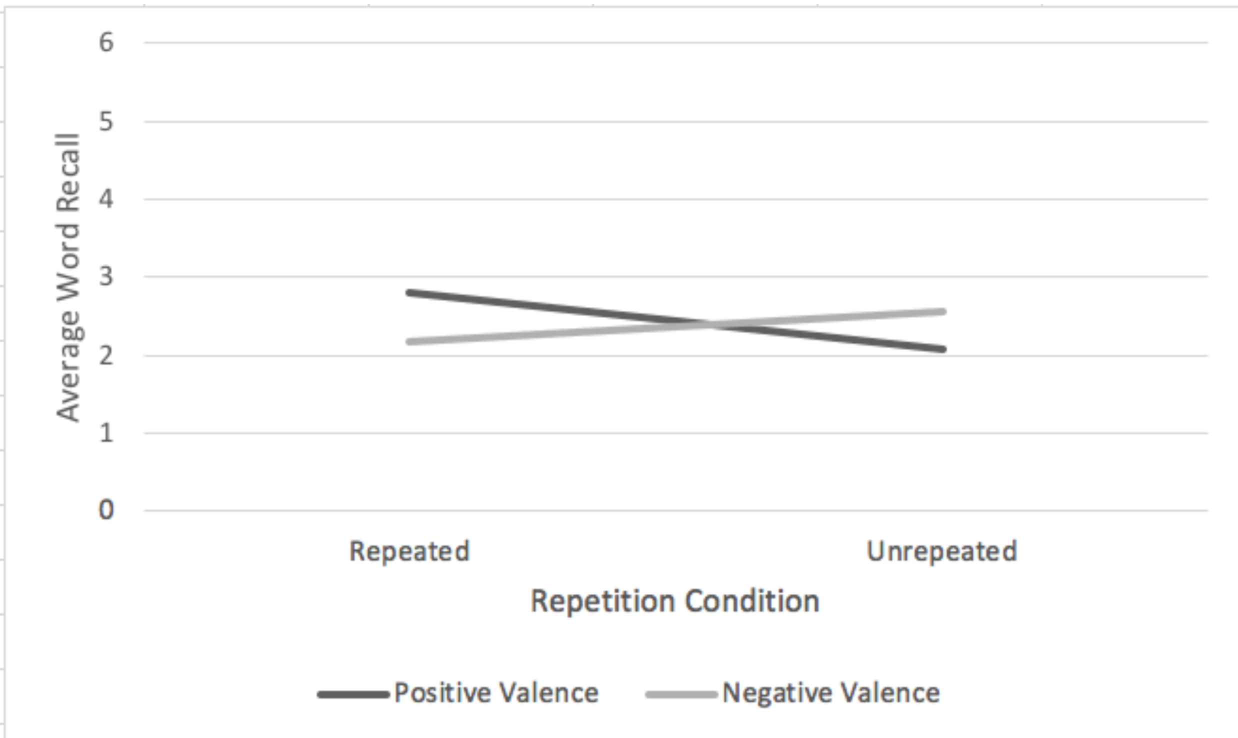


Figure 3

Interaction of Arousal and Repetition with Pair Data

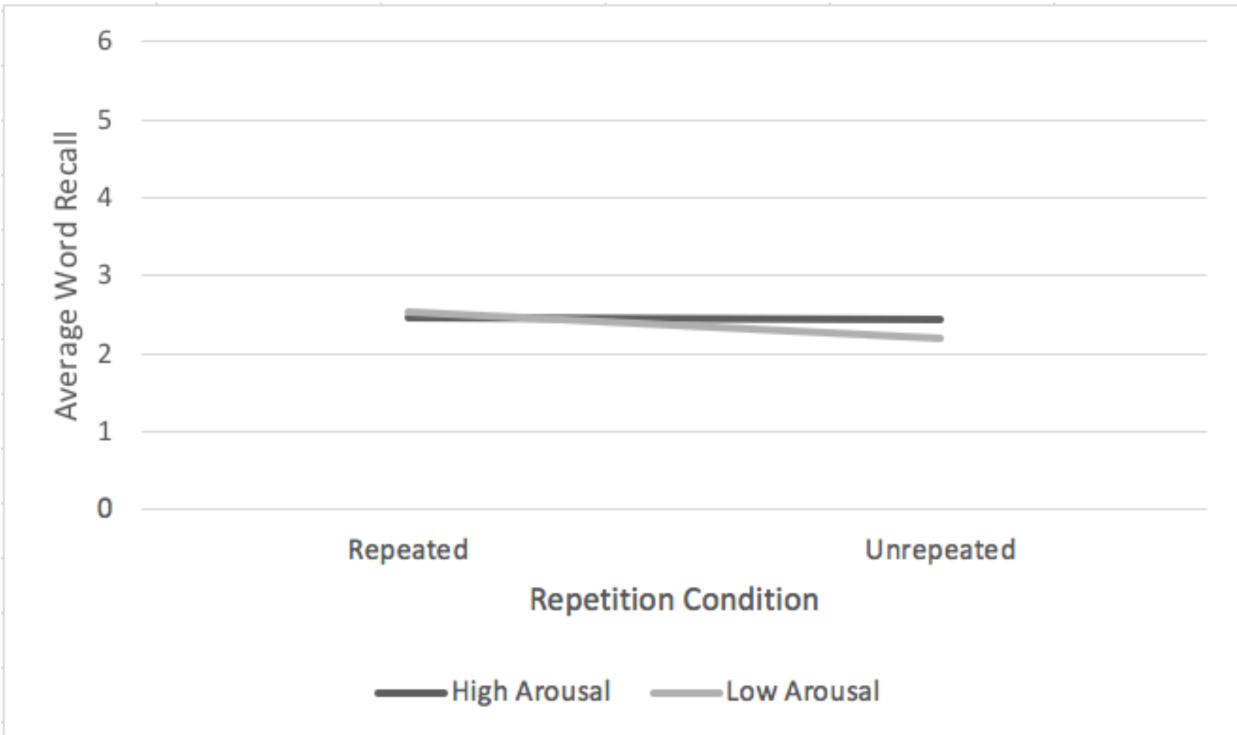


Figure 4

Interaction of Arousal and Valence with Pair Data

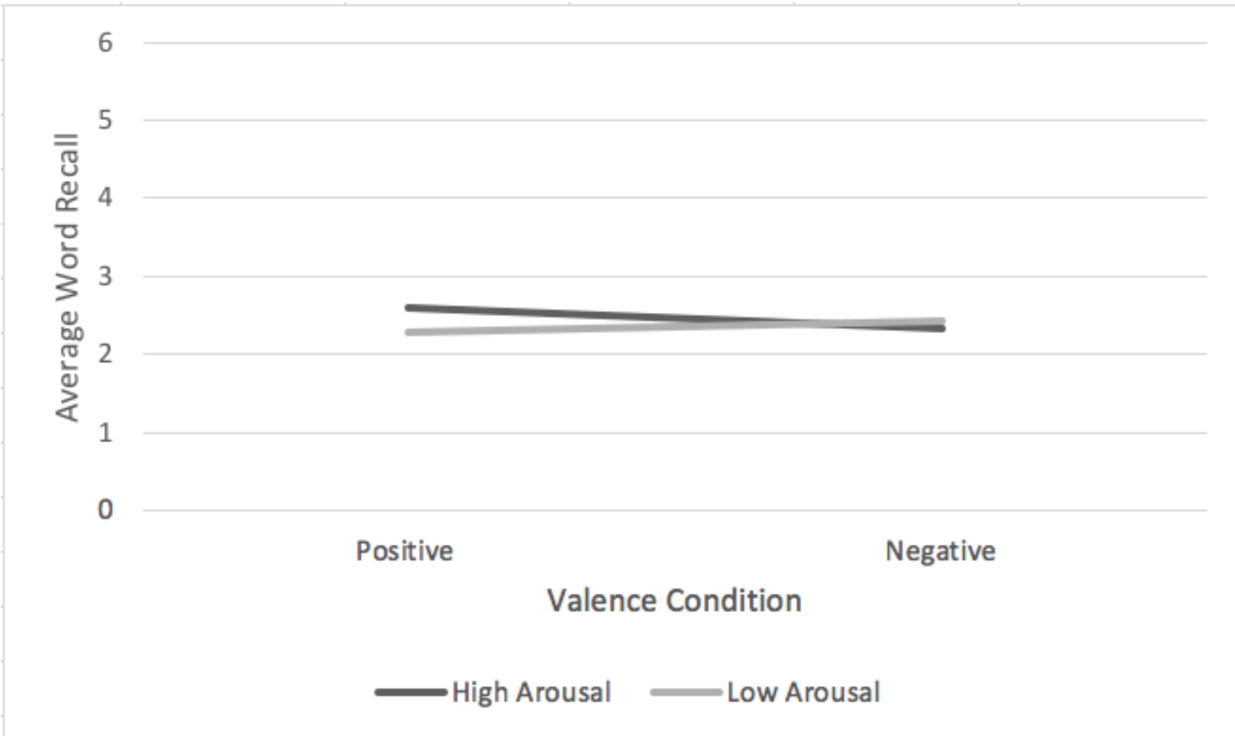


Figure 5

Interaction of Valence and Repetition with Pair Data

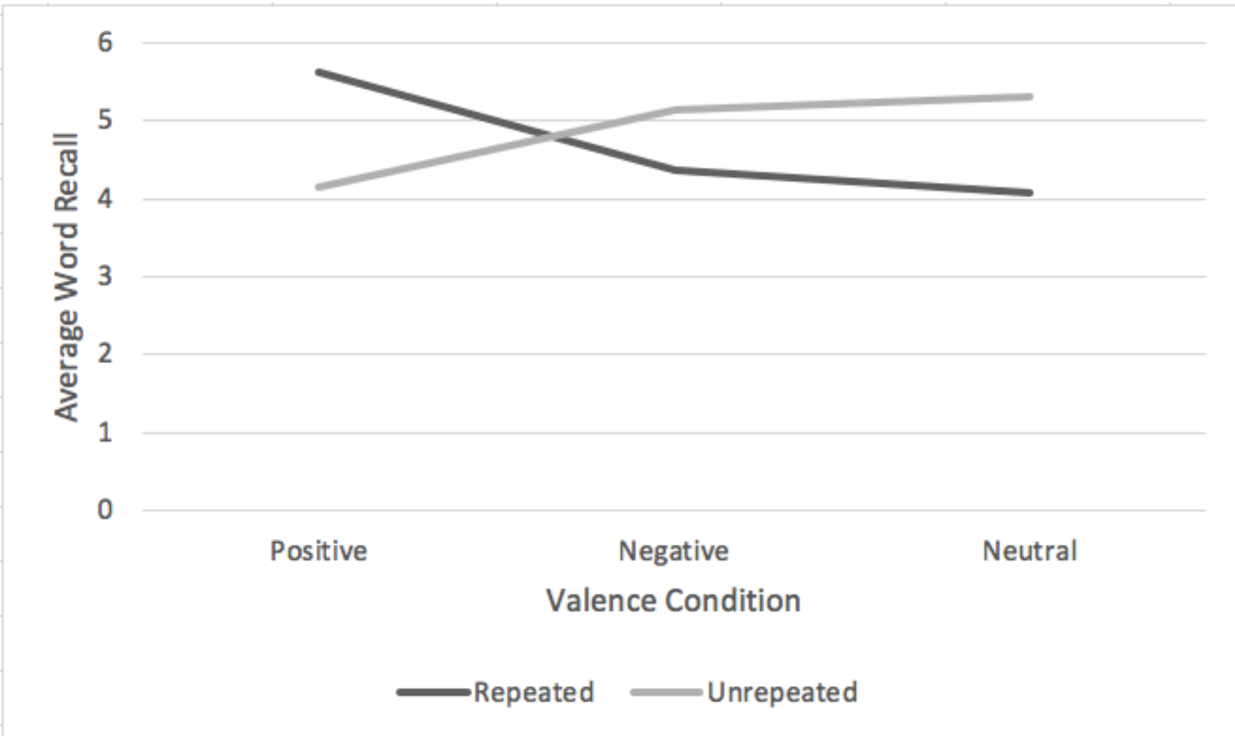


Figure 6

Interaction of Valence and Arousal with Target Location Data

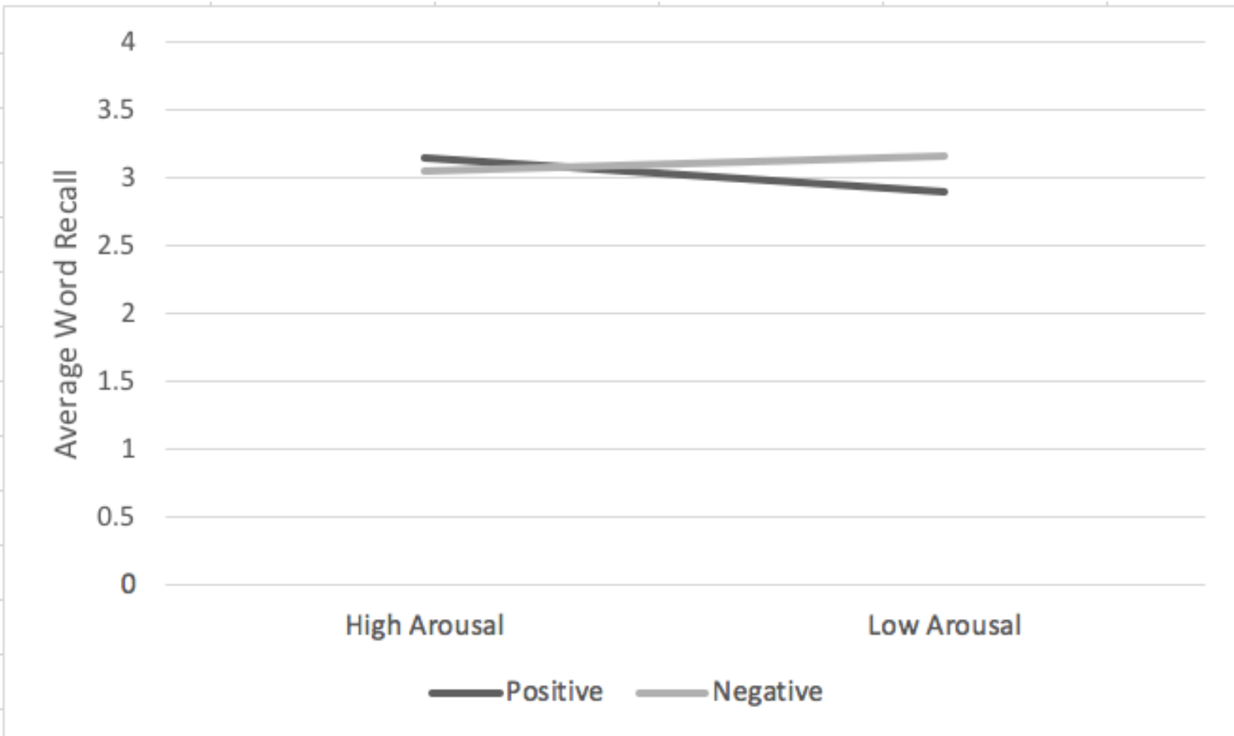


Figure 7

Interaction of Valence and Repetition with Target Location Data

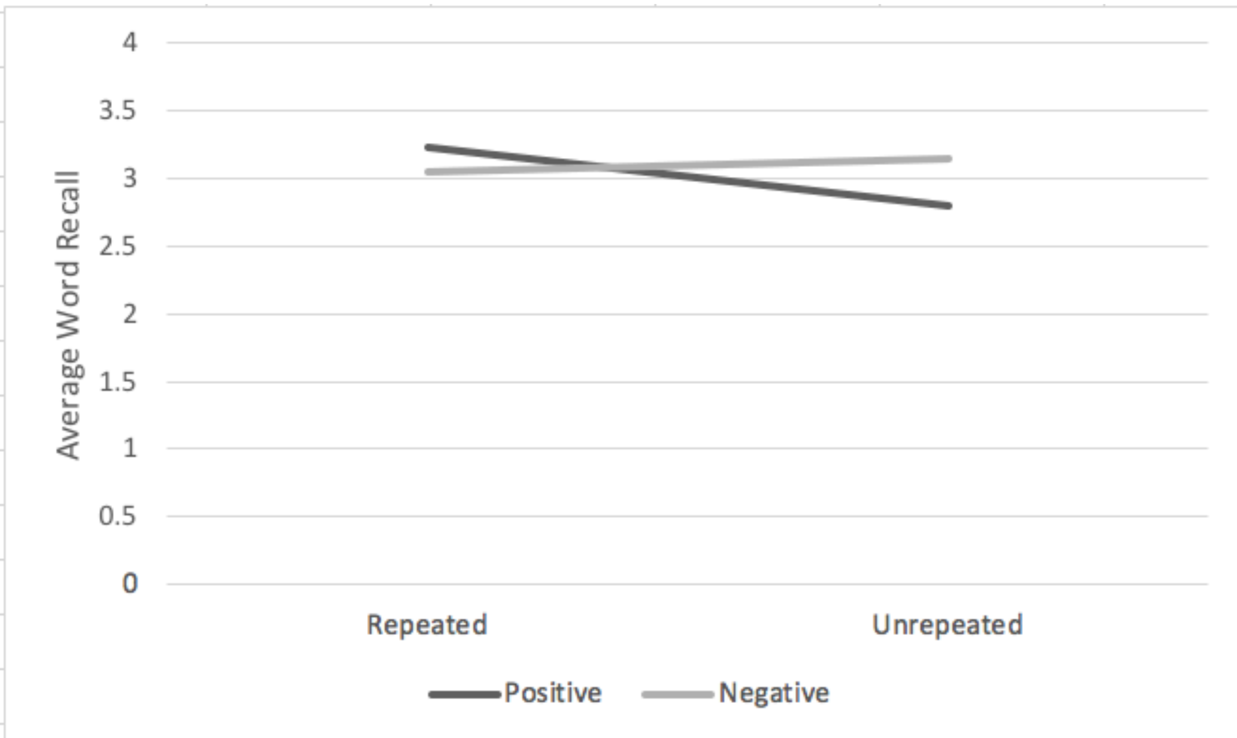


Figure 8

Interaction of Valence and Target Location with Target Location Data

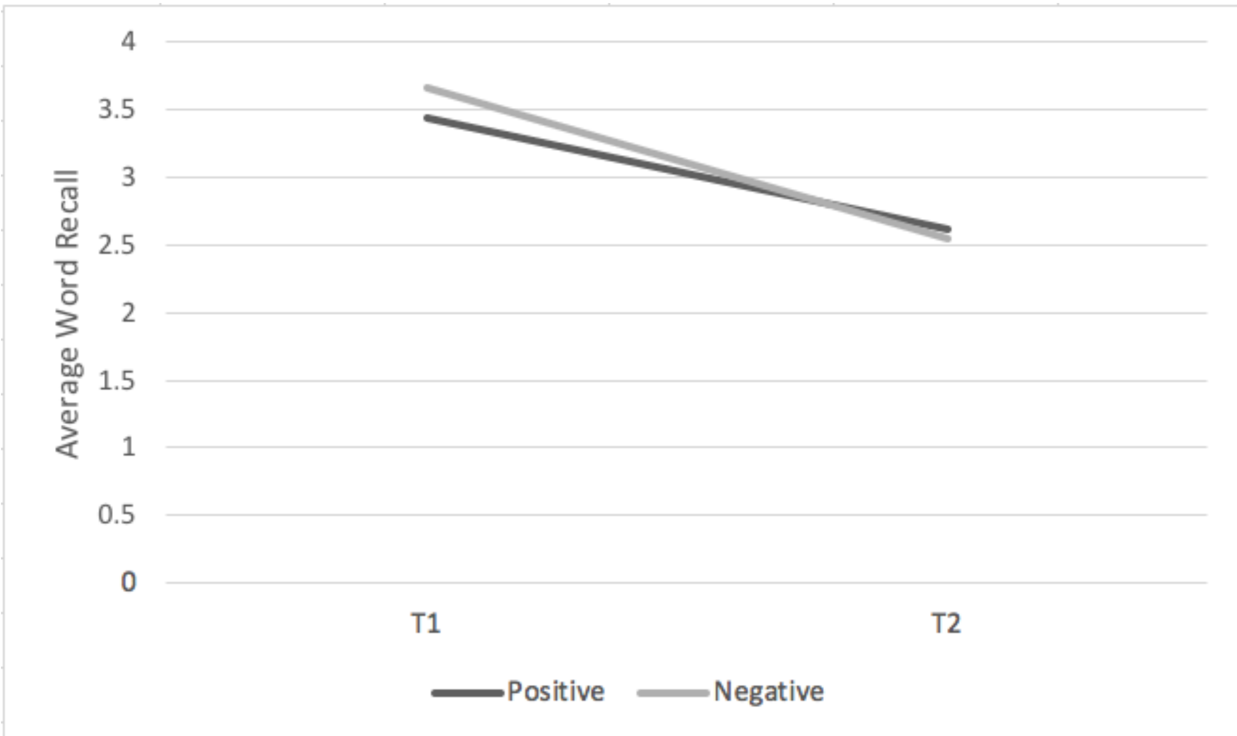


Figure 9

Interaction of Arousal and Target Location with Target Location Data

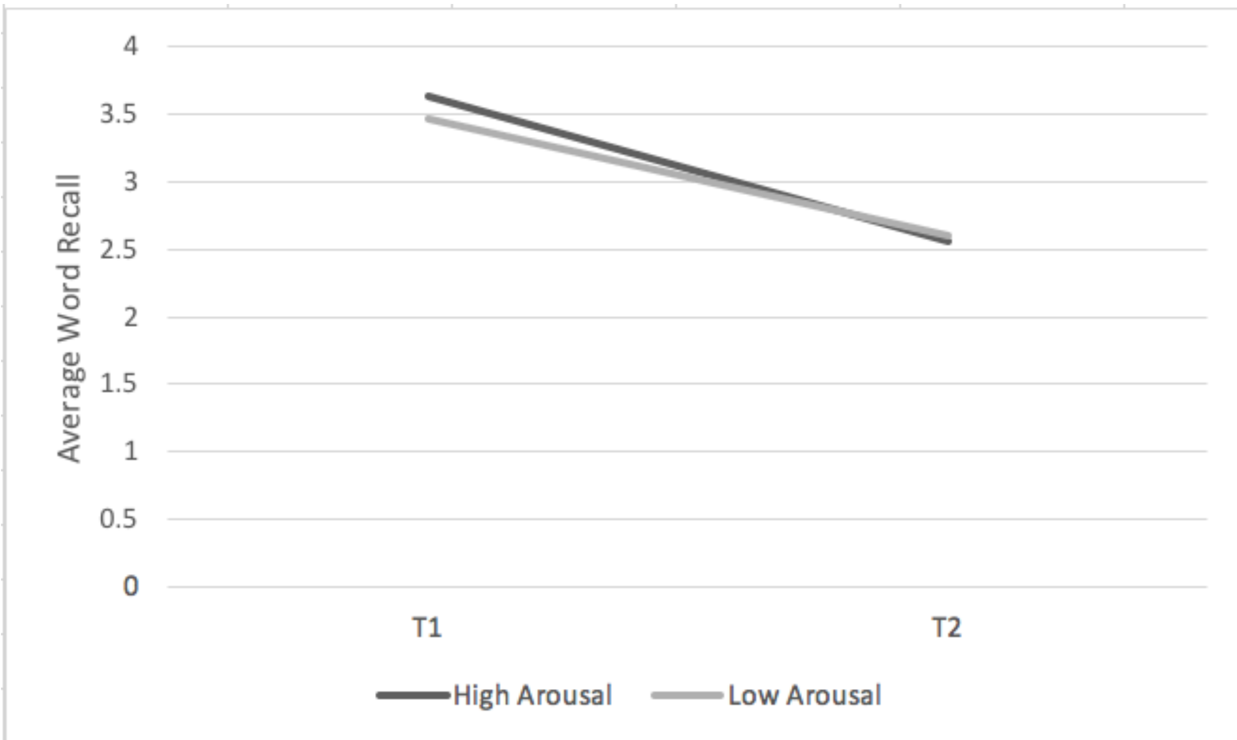


Figure 10

Interaction of Repetition and Target Location with Target Location Data

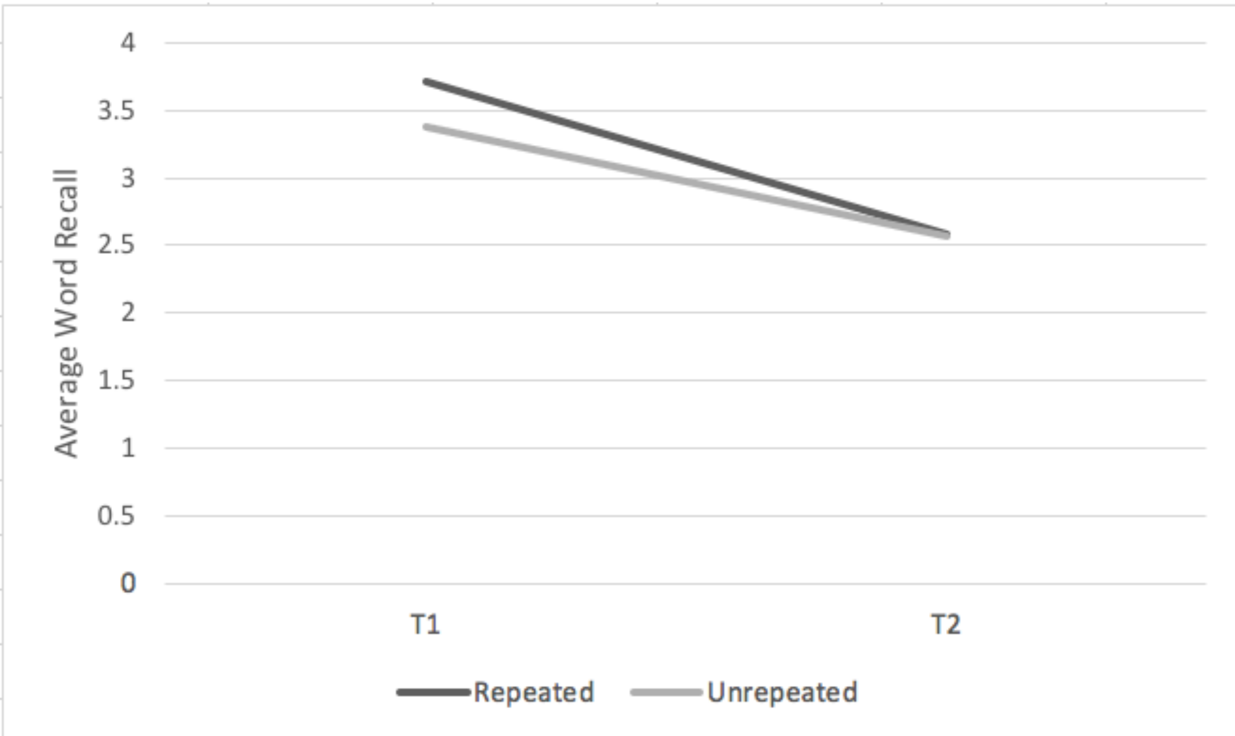


Figure 11

Interaction of Valence, Repetition, and Target Location with Target Location Data

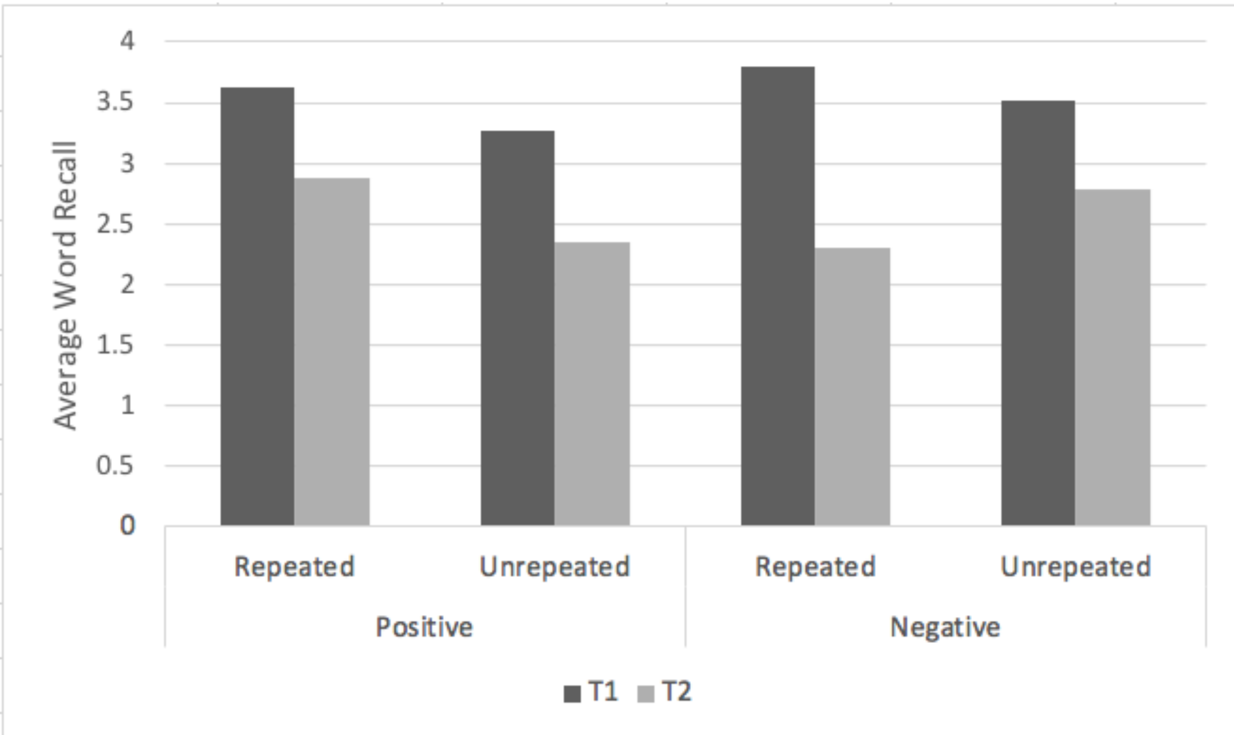


Figure 12

Interaction of Valence and Repetition with Neutral Target Location Data

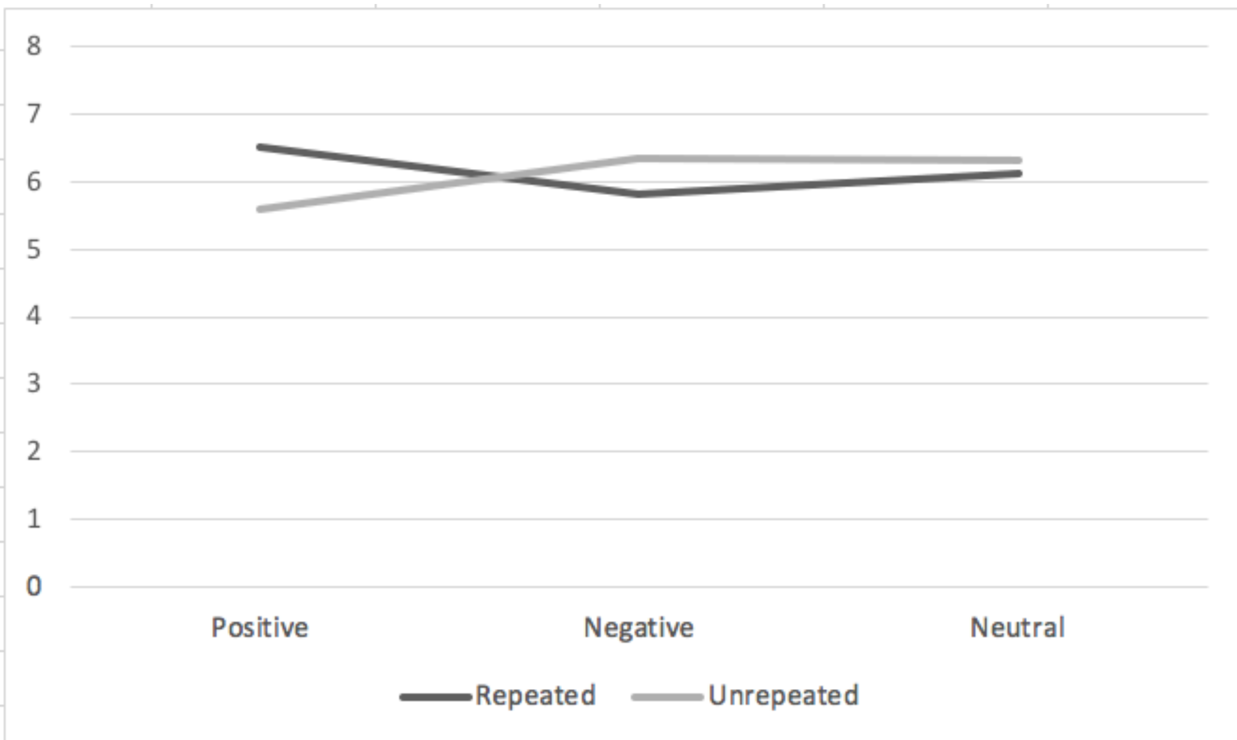


Figure 13

Interaction of Valence and Target Location with Neutral Target Location Data

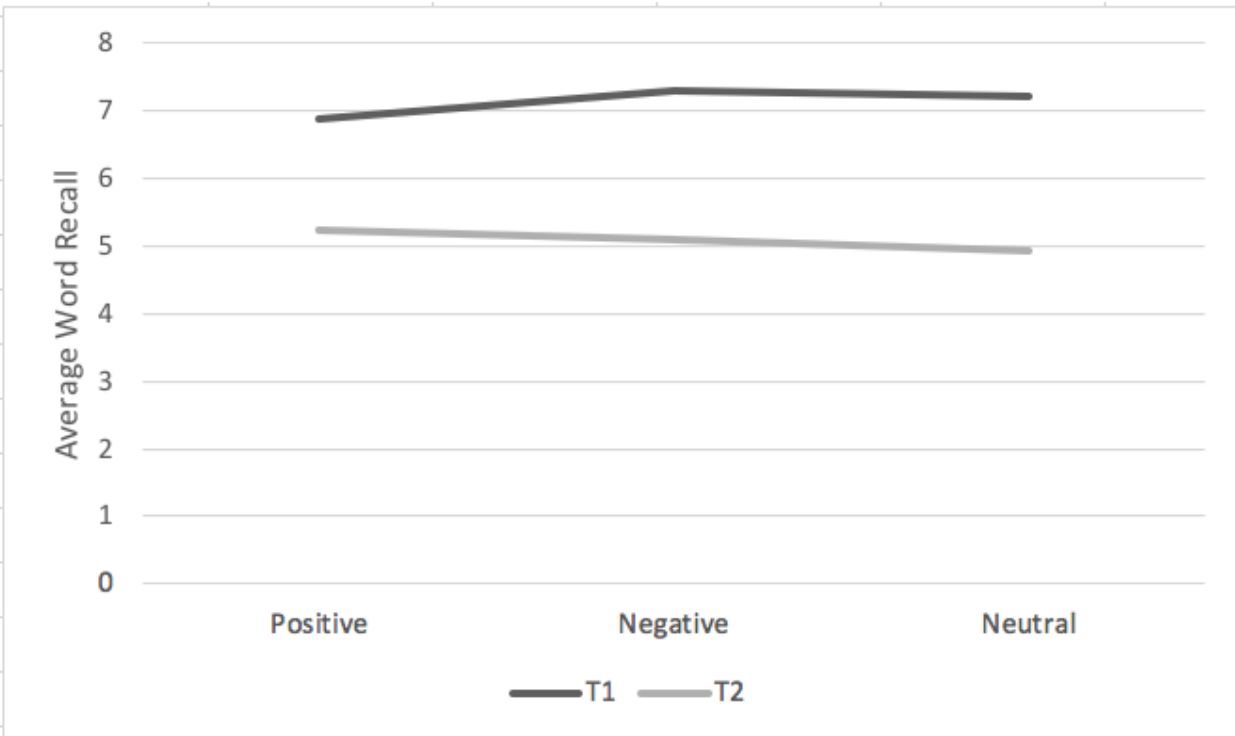


Figure 14

Interaction of Repetition and Target Location with Neutral Target Location Data

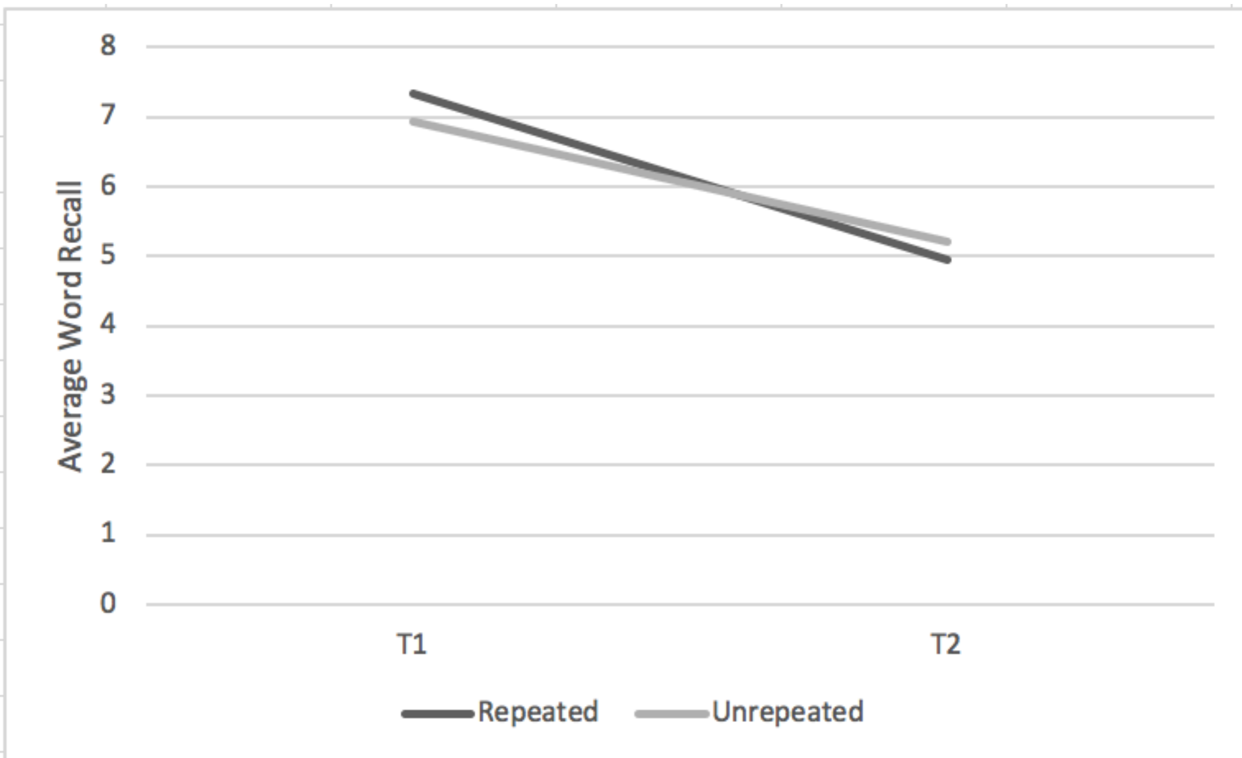


Figure 15

Interaction of Valence, Repetition, and Target Location with Neutral Target Location Data

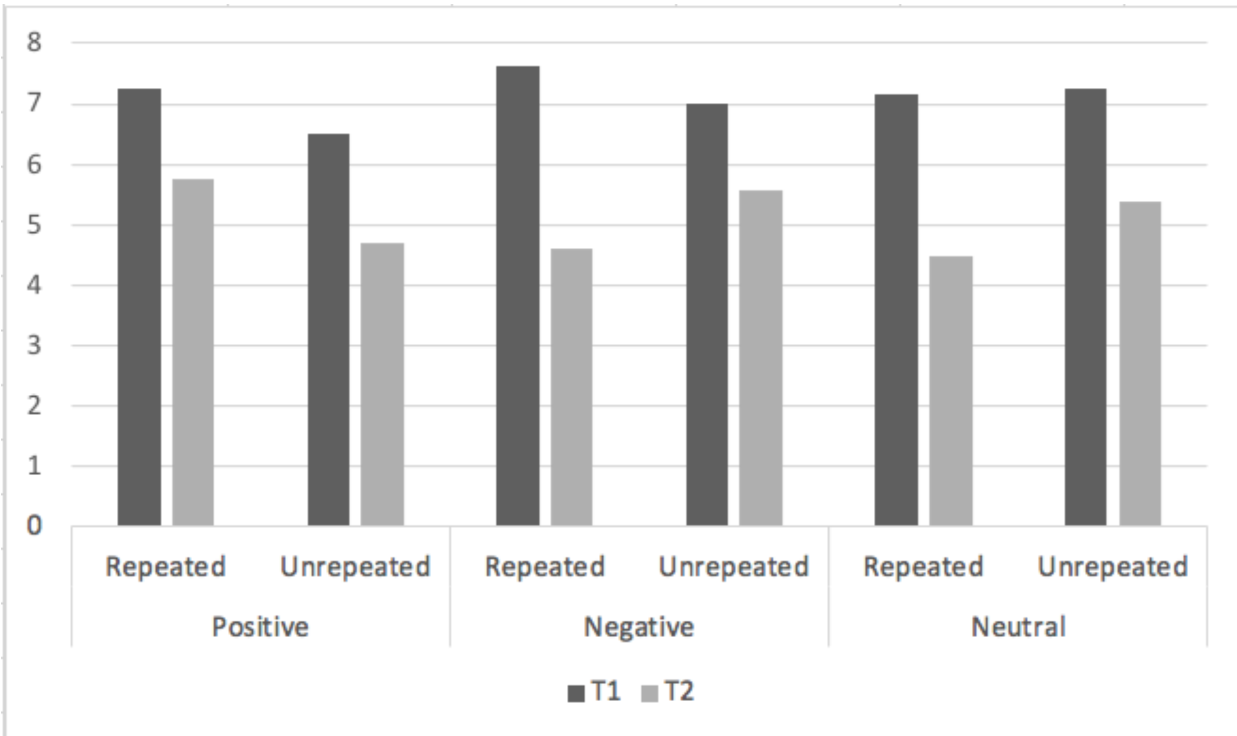


Table 1

Length, Frequency, SAM Ratings, and ANEW Ratings of Target Words

Arousal and Valence Ratings of Target Words						
			SAM Ratings		ANEW Ratings	
Word	Length	Frequency	Valence (S. D.)	Arousal (S. D.)	Valence (S. D.)	Arousal (S. D.)
Negative Low Arousal Words						
Weary	5	4.16	2.73 (1.13)	4.04 (2.24)	3.79 (1.92)	3.81 (2.29)
Sad	3	63.67	1.95 (1.08)	4.02 (2.22)	1.61 (0.95)	4.13 (2.38)
Unhappy	7	16.53	1.93 (1.26)	4.58 (2.06)	1.57 (0.96)	4.18 (2.50)
Pain	4	97.94	1.84 (1.40)	6.38 (2.14)	2.13 (1.81)	6.50 (2.49)
Mad	3	113.41	2.09 (1.34)	6.87 (2.20)	2.44 (1.72)	6.76 (2.26)
Lonely	6	41.67	1.53 (0.90)	4.09 (2.41)	2.17 (1.76)	4.51 (2.68)
Guilty	6	62.29	1.84 (1.05)	5.82 (2.68)	2.63 (1.98)	6.04 (2.76)
Upset	5	74.51	1.80 (0.93)	5.36 (2.31)	2.00 (1.18)	5.86 (2.40)
Nervous	7	67.16	2.36 (1.10)	7.09 (2.01)	3.29 (1.47)	6.59 (2.07)
Indifferent	11	1.14	4.71 (1.29)	3.29 (1.87)	4.61 (1.28)	3.18 (1.85)
Bored	5	20.18	3.36 (1.19)	2.87 (2.10)	2.95 (1.35)	2.83 (2.31)
Timid	5	1.51	3.22 (1.29)	3.91 (2.15)	3.86 (1.55)	4.11 (2.09)
Negative High Arousal Words						
Angry	5	58.98	1.85 (1.13)	7.40 (2.28)	2.85 (1.70)	7.17 (2.07)
Panic	5	21.84	1.45 (1.02)	8.07 (2.04)	3.12 (1.84)	7.02 (2.02)

Fear	4	69.08	2.09 (1.24)	7.18 (1.88)	2.76 (2.12)	6.96 (2.17)
Hate	4	214.59	1.82 (1.31)	7.16 (2.36)	2.12 (1.72)	6.95 (2.56)
Distressed	10	1.39	2.13 (1.16)	6.58 (2.32)	1.94 (1.10)	6.40 (2.38)
Enraged	7	0.69	2.07 (2.21)	8.20 (1.86)	2.46 (1.65)	7.97 (2.17)
Terrified	9	9.57	1.49 (1.02)	7.80 (2.08)	1.72 (1.14)	7.86 (2.27)
Horror	6	9.18	2.20 (1.70)	7.76 (1.88)	2.76 (2.25)	7.21 (2.14)
Stress	6	15.61	1.82 (1.17)	7.25 (2.07)	2.09 (1.41)	7.45 (2.38)
Embarrassed	11	21.43	2.07 (1.02)	6.45 (2.22)	3.03 (1.85)	5.87 (2.55)
Afraid	6	247.67	2.00 (1.37)	6.69 (2.06)	2.00 (1.28)	6.67 (2.54)
Mad	3	113.41	2.25 (1.21)	6.62 (2.33)	2.44 (1.72)	6.76 (2.26)
Positive Low Arousal Words						
Relaxed	7	6.98	7.42 (1.40)	1.84 (1.46)	7.00 (1.77)	2.39 (2.13)
Dignified	9	2.69	6.67 (1.56)	4.42 (2.16)	7.10 (1.26)	4.12 (2.29)
Carefree	8	1.35	7.64 (1.32)	3.40 (2.32)	7.54 (1.38)	4.17 (2.84)
Comfort	7	17.22	7.69 (1.50)	2.85 (2.23)	7.07 (2.14)	3.93 (2.85)
Thankful	8	5.37	7.80 (1.28)	4.29 (2.11)	6.89 (2.29)	4.34 (2.31)
Untroubled	10	0.08	7.09 (1.52)	2.75 (2.03)	7.62 (1.41)	3.89 (2.54)
Secure	6	24.33	7.76 (0.96)	3.27 (2.30)	7.57 (1.76)	3.14 (2.47)
Proud	5	83.63	7.76 (1.20)	6.00 (2.19)	8.03 (1.56)	5.56 (3.01)
Safe	4	143.20	7.75 (1.19)	2.35 (1.69)	7.07 (1.90)	3.86 (2.72)

Cozy	4	5.65	7.60 (1.51)	2.73 (2.13)	7.39 (1.53)	3.32 (2.28)
Kindness	8	9.02	7.98 (1.06)	4.60 (2.02)	7.82 (1.39)	4.30 (2.62)
Politeness	10	0.57	7.11 (1.42)	3.84 (1.90)	7.18 (1.50)	3.74 (2.37)
Positive High Arousal Words						
Adored	6	2.45	8.29 (1.00)	6.15 (2.22)	7.74 (1.84)	6.11 (2.36)
Joy	3	28.55	8.25 (1.08)	6.71 (1.91)	8.60 (0.71)	7.22 (2.13)
Happy	5	333.20	7.76 (1.72)	5.73 (2.27)	8.21 (1.82)	6.49 (2.77)
Aroused	7	2.22	7.18 (1.45)	7.80 (1.75)	7.97 (1.00)	6.63 (2.70)
Excitement	10	0.04	8.04 (1.12)	8.04 (1.37)	7.50 (2.20)	7.67 (1.91)
Ecstasy	7	3.18	7.29 (2.42)	6.56 (2.67)	7.98 (1.52)	7.38 (1.92)
Surprised	9	55.06	6.31 (1.90)	7.96 (1.45)	7.47 (1.56)	7.47 (2.09)
Passion	7	19.76	7.84 (1.07)	7.40 (1.91)	7.80 (1.14)	7.70 (1.89)
Triumphant	10	1.37	8.20 (1.70)	7.13 (2.03)	8.82 (0.73)	6.78 (2.58)
Elated	6	0.27	7.98 (1.53)	6.73 (2.05)	7.45 (1.77)	6.21 (2.30)
Brave	5	31.71	7.51 (1.36)	6.71 (1.93)	7.15 (1.64)	6.15 (2.45)
Confident	9	10.65	7.67 (1.36)	5.95 (2.12)	7.98 (1.29)	6.22 (2.41)
Neutral Words—Furniture						
Chair	5	49.24	5.05 (0.85)	3.00 (1.94)		
Window	6	86.00	5.16 (1.15)	3.47 (2.01)		

Couch	5	23.47	5.64 (1.21)	2.73 (1.68)		
Door	4	292.06	5.09 (0.67)	3.33 (1.91)		
Lamp	4	12.88	4.96 (0.77)	3.27 (1.97)		
Table	5	105.63	4.89 (0.81)	3.22 (2.00)		
Wall	4	70.69	4.75 (0.89)	3.25 (1.89)		
Fireplace	9	5.08	6.45 (1.35)	3.24 (1.94)		
Floor	5	100.63	4.96 (0.51)	3.18 (2.12)		
Ceiling	7	8.35	5.00 (0.70)	3.18 (2.07)		
Sofa	4	5.86	5.64 (1.19)	2.67 (1.97)		
Carpet	6	11.65	5.15 (1.08)	2.96 (1.89)		
Neutral Words—Appliances						
Oven	4	8.88	5.00 (1.05)	3.44 (1.81)		
TV	2	101.94	5.82 (1.39)	3.85 (1.80)		
Radio	5	77.18	5.40 (1.26)	4.35 (2.02)	6.73 (1.47)	4.78 (2.82)
Washer	6	2.04	4.89 (0.83)	3.35 (2.05)		
Blender	7	1.67	5.02 (0.81)	3.87 (2.28)		
Mixer	5	1.08	5.33 (0.84)	4.36 (2.36)		
Iron	4	17.94	4.85 (1.08)	3.73 (2.28)	4.90 (1.02)	3.76 (2.06)
Dryer	5	4.53	5.04 (0.88)	3.40 (2.00)		

Toaster	7	3.88	5.05 (0.80)	3.33 (1.91)		
Stove	5	7.59	5.00 (1.16)	3.62 (2.04)	4.98 (1.69)	4.51 (2.14)
Refrigerator	12	0.49	5.11 (1.30)	3.05 (1.82)		
Dishwasher	10	0.18	4.89 (1.03)	3.02 (2.01)		

Note. Neutral words were not rated by SAM participants, and only some of the neutral words were included in ANEW. Therefore, the valence and arousal values of some neutral words are not presented in the Table.

Table 2

Average Valence and Arousal Values for Each Word Type

Average Values by Stimulus Type				
	Valence	Arousal	Frequency	Word Length
Negative Low Arousal	2.75	4.87	47.01	5.58
Negative High Arousal	2.53	7.02	65.29	6.33
Positive Low Arousal	7.36	3.90	25.00	7.16
Positive High Arousal	7.99	6.83	40.71	6.83

Appendix

Negative Low Arousal Sentences

He is weary and she is weary because they have been awake for many hours. (R)

Jackie has been sad because Karen was sad about the break-up. (R)

I am unhappy and she is unhappy that we are still married. (R)

Veronica felt great pain from the pain created by her broken leg. (R)

I am mad and she is lonely because our rooms are separate. (U)

Bob felt guilty because he upset the children. (U)

The doctor was nervous about the indifferent nurse with little experience. (U)

Eric is bored by the timid babysitter and her efforts to talk. (U)

Negative High Arousal Sentences

Emma is angry about her angry sibling tattling on her. (R)

She felt panic and he felt panic as someone opened the door. (R)

The captain felt fear because of his fear of a bad storm. (R)

She hates when others use hate to justify negative acts and crimes. (R)

I felt distressed when my enraged stepdad tried to punish me. (U)

Brian was terrified of the horror unfolding before his eyes. (U)

He felt a lot of stress after being embarrassed at the party. (U)

We are afraid when our teacher gets mad at us. (U)

Positive Low Arousal Sentence

He is relaxed and I am relaxed because we went to the spa. (R)

She feels dignified and I feel dignified now that we are retired. (R)

I am carefree and Kelly is carefree now that we are on vacation. (R)

Karen felt comfort and Dave felt comfort while they watched their children. (R)

Piper is thankful because she is untroubled by her thoughts. (U)

Janet felt secure because Roger was proud of her accomplishments. (U)

He felt safe once the cozy cabin was in his sight. (U)

She often exhibited kindness and politeness towards others in her class. (U)

Positive High Arousal Sentences

The girl adored cats but she adored dogs even more. (R)

I feel joy when there is joy on others' faces. (R)

His family is happy that he is happy with his new wife. (R)

He is aroused and they are aroused by the business prospect. (R)

Andrea feels excitement and ecstasy now that she has received her diploma. (U)

Ron was surprised by Mary's passion for dancing. (U)

He is triumphant and elated that he got the job. (U)

Her brave and confident nature make her a viable political candidate. (U)

Neutral Sentences(Living Room Furniture)

They are sitting in his chair and her chair on the porch. (R)

Their bathroom window and our kitchen window are facing each other. (R)

I prefer that couch to the couch with blue suede upholstery. (R)

Both the outer door and screen door need to be replaced. (R)

I think the lamp on the table should be moved elsewhere. (U)

Tyler wants to repaint the wall with the fireplace on it. (U)

The room has a dark hardwood floor and very high ceiling. (U)

He likes that the sofa matches the carpet in the living room. (U)

Neutral Sentences (Household Appliances)

I prefer the oven to the microwave oven for reheating my food. (R)

Her new TV makes my TV look really small. (R)

Jenna changes the radio station on the radio in her car. (R)

My washer and his washer are the same kind but different colors.

I use the blender instead of the mixer to make whipped cream. (U)

He uses the iron when the dryer wrinkles his shirts. (U)

Her secret is using the toaster instead of the stove to make food crispy. (U)

Move the jar from the refrigerator to the dishwasher in the corner. (U)

Practice Trials

I use hot water instead of cold water when I shower.

I like chocolate milk and regular milk but he does not.

Both orange juice and cranberry juice are sold at the supermarket.

I want a new soda because this soda is too warm.

He drinks beer and she drinks wine at the party.

She drinks tea and I prefer coffee in the morning.

The truck needs gasoline and oil in order to work.

Jeremy prefers liquor because its alcohol content is higher than other drinks.