4-1-2020

Investigating Emotion-label and Emotion-laden Words in a Semantic Satiation Paradigm

Ryan Hildebrandt
rch6608@rit.edu

Recommended Citation

Hildebrandt, Ryan, "Investigating Emotion-label and Emotion-laden Words in a Semantic Satiation Paradigm" (2020). Thesis. Rochester Institute of Technology. Accessed from

Department of Psychology, College of Liberal Arts
Rochester Institute of Technology

Investigating Emotion-label and Emotion-laden Words in a Semantic Satiation Paradigm

by

Ryan Hildebrandt

A Thesis in

Experimental Psychology

Submitted in Partial Fulfillment of the Requirements for the Degree of

Master of Science

April 1, 2020

We approve the thesis of Ryan Hildebrandt:

Dr. Tina Sutton Date

Associate Professor, Rochester Institute of Technology

Faculty Adviser and Chair of the Thesis Committee

Dr. Andrew Herbert Date

Professor, Rochester Institute of Technology

Reader

Dr. Stephanie Kazanas Date

Assistant Professor, Tennessee Technological University

Reader

Acknowledgements

Huge thanks to Dr. Tina Sutton for advising me through this research process and keeping me on track to complete my degree, as well as Dr. Andrew Herbert and Dr. Stephanie Kazanas for being on my committee and offering their expertise as the present study developed.

Abstract

Current literature suggests emotion-label words (e.g., sad) and emotion-laden words (e.g., funeral) are processed differently. The central focus of the present study was to investigate how valence and emotion word type influence how words are processed. A satiation paradigm was used to characterize the relationship between the processing of emotion-label and emotion-laden words of positive and negative valence. It was hypothesized that, in addition to the standard slowed response times to satiated words, emotion-label words would exhibit greater satiation and priming effects than emotion-laden words. Analyses indicated expected priming and satiation effects across a range of other stimulus characteristics. Neutral words, which were included as a comparison stimulus type for both valence and word type variables, were shown to elicit much slower reaction times than either emotion word type. The results of the present study indicate the importance of valence in word processing, even when other word characteristics and experimental variables are at play. Current models of word processing do not sufficiently account for emotional characteristics of words, and implications for word processing models are discussed.

Keywords: word processing, emotion words, satiation, priming, attention, emotion-laden words

Contents

List of Tables

List of Figures

List of Appendices

Investigating Emotion-label and Emotion-laden Words in a Semantic Satiation Paradigm

The central focus of the present study was to investigate how emotional characteristics of a word (e.g., valence) are related to word type, and how they may interact during processing. The present study also sought to contribute to research regarding differences between emotion-label words (e.g., “happy”) and emotion-laden words (e.g., “birthday”), as well as current word processing models. Addressing these core questions draws on studies suggesting emotion words are processed differently than other word types (e.g., concrete words such as “chair”, and abstract words such as “idea”). To assess how semantic features of emotion words are processed differently based on word type, the present study employed a satiation paradigm, which allows for manipulation of the availability of a given word’s meaning. Previous literature as well as findings from the present study will then be discussed with regard to how they may inform word processing models.

Word Recognition

Word recognition is an essential prerequisite for higher level language processing. Being able to recognize a word is necessary for attaching meaning to that word and for being able to understand it in its context, whether in the middle of a conversation or a written sentence on a page. There are a range of word recognition models, all with varying approaches to the question of how words are perceived, processed, and represented in the brain. These models consist of three broad categories: search models, activation models, and parallel distributed processing models. The extent to which each model accounts for different phenomena speaks to each models’ usefulness in a particular research context. All of these models, however, are based on the simple idea of lexical access, which is the activation (access) of a particular word’s representation in the brain (Posner & Carr, 1992). Although the specific details and neural underpinnings of lexical access itself are not well understood (Laszlo & Plaut, 2012), the models discussed here seek to describe how lexical access is achieved based on a range of lexical characteristics and cognitive processes.

At the core of all search models is the process of comparing the presented word in the form of a pre-lexical stimulus (the word in question, encoded into its different perceptual features but not yet associated with any lexical meaning) against a set of meaningful lexical features, stored in lexical memory (i.e., the lexicon) (Lupker, 2008). Many of the more simple search models are limited in their ability to account for semantic effects other than priming (specifically semantic effects and word frequency) because of the relative simplicity of the search process (Lupker, 2008). The main word recognition effect these models are able to account for is repetition priming. The search-based account of word processing indicates that priming effects should only be seen when the target is successfully accessed from the lexicon; however, priming effects have been demonstrated via masked priming procedures, in which a prime is presented in a way that prevents conscious recognition of the word, thereby preventing it from being accessed from the lexicon (Kazanas, 2013; Kazanas & Altarriba, 2015a). These findings stand in direct contrast to predictions from basic search models and reflect a more complex interaction of word characteristics' effects on processing. Explaining effects of word characteristics such as valence and arousal on word recognition would be difficult for search models, as a simple lexical search process lacks the complexity to account for influences of such characteristics. Accounting for more complex effects seen in word recognition requires a more dynamic model, such as activation models.

Activation models are better able to account for the complexity of cognitive processing during word recognition via integration of neural activation and inhibition processes. In many activation models, a constant flow of lower level (feature- and letter-based) activation to higher level (word-based) activation as well as high level to low level activation combine to produce the identification of a word when a similarity threshold is reached (Lupker, 2008). Frequency effects are accounted for in activation models, as neural representations of higher frequency words will be more readily able to reach their activation threshold, resulting in more ready lexical access. Masked priming effects are also much more effectively explained by activation models, as even brief exposure to a prime would activate parts of its lexical representation, and the residual activity in those areas would be more readily activated and assembled into the full prime or a related word (Lupker, 2008). Activation models are better able to explain observed effects of semantic properties of a word, such as the concreteness or abstractness of a word. The more concrete and imaginable a word is, the more accessible it is via activation of any number of representations of the word in the brain, and thereby more quickly accessed from the lexicon (Paivio, 1986). The model falls short; however, in its explanation of processing advantages seen for other semantic properties, namely arousal and valence characteristics of a word. These characteristics would not, according to activation models, make a word more accessible (Lupker, 2008), and external mechanisms are required to explain observed increases in availability based on valence and arousal. This reliance on external mechanisms reflects a gap in activation-based models' ability to explain the impacts of word characteristics on processing.

A more recent wave of word processing models, called parallel distributed processing models or PDP models (McClelland & Rumelhart, 1987), argue that the lexical representations relied upon in search and activation models are more spread out in the lexicon, with each of a word's lexical features being represented independently of one another. "Accessing" a word in the lexicon is, according to these models, an activation of all the individual lexical features which correspond to the word being accessed (Lupker, 2008). These features are represented at different levels of processing (orthographic, semantic, etc.), and they interact with one another, activating or inhibiting related representations. This process is repeated and refined over time, wherein the brain essentially learns the most relevant and advantageous activation pattern for a particular word stimulus.

The more interconnected nature of PDP models is better able to account for the complexity of factors which can impact word recognition, and is thought to be a better representation of the process as a whole. Word frequency effects are essentially built into these models of word recognition, as the frequency of a particular word-related activation is the main factor which increases the speed and accuracy of any lexical access (Lupker, 2008). Because this model is also based on neural activation and inhibition, it explains masked priming in much the same way that more conventional activation models do. Just as in activation models, lexical access can be facilitated through residual activity in lexical features from a recently accessed stimulus, such as a prime. Though masked priming prevents explicit recognition of a prime, activation of individual features from a masked stimulus is still sufficient to facilitate later access of those features as a part of a word stimulus. PDP models are especially good at accounting for semantic priming effects, as any number of the activated semantic features of a primed stimulus can be activated more readily when processing a new stimulus related to the prime (Lupker, 2008). These models are still, much like activation models, limited in their ability to account for the emotional properties of a word during the recognition processes.

Emotional Words

Early research into different types of words suggested two categories: concrete words which refer to things which exist independently of the human mind (e.g., “chair”, “dog”), and abstract words which refer to things that only exist in relation to the mind or language (e.g., “ego”, “honesty”) (Kousta, Vigliocco, Vinson, Andrews, & Del Campo, 2011). Over time however, more and more research indicated the existence of a third category, distinct from both abstract and concrete words: emotion words. Altarriba and Bauer (2004) define emotion words as words with an affective meaning, possessing both arousal and valence characteristics (e.g., “happiness”, “fear”). In a pair of studies, Altarriba, Bauer, and Benvenuto (1999) looked at the differences in these three word categories. In Experiment 1 of the study, participants rated a list of concrete, abstract, and emotion words on their concreteness (how concrete versus abstract a word was perceived to be), imageability (the ease with which participants could form an image of the word), and context availability (how easily the given word was associated with a particular context or circumstance in which the word would appear). These ratings reflected significant differences between the three word types, with emotion words being less concrete and lower in context availability than abstract and concrete words, and more imageable than abstract words, but less imageable than concrete words. In Experiment 2, participants completed a word association task in which they were instructed to respond with the first word that came to mind for a given target word (either an abstract, concrete, or emotion word). The proportion of participants responding with a particular word was used to rank the strength of the association between the word and its associate, and these ratings were aggregated into the mean association strength for each word type. This experiment found that associations for emotion words were significantly stronger when compared to abstract and concrete words, and that emotion words had on average a higher number of associated words than other word types (Altarriba et al., 1999). Also exploring these ratings, Altarriba and Bauer (2004) used a set of three experiments to investigate differences in word types, beginning with comparing abstract, concrete, and emotion words in how well they were recalled from a list. In Experiment 1, emotion words were recalled more frequently than either abstract or concrete words. The researchers also collected ratings on words from all three categories on concreteness, imageability, and context availability. Despite emotion words' inclusion in the abstract word category in many previous studies, it was found that emotion words differed significantly from both abstract and concrete words on all three of the scales of interest. Emotion words were rated as less imageable and higher in context availability than abstract words, while also being less concrete than abstract words. Emotion words were also less concrete, less imageable, and had lower context availability than concrete words. In the third experiment, abstract and emotion words were compared in a primed lexical decision task (LDT). In this task, both types of words primed within their category (abstract words primed abstract words and emotion words primed emotion words), and a significant priming effect was also found between abstract and emotion words, such that abstract words primed emotion words, but not the other way around. Altarriba and Bauer (2004) attribute these results to the ways in which abstract and emotion words activate semantic associations differently during lexical access, consistent with a semantic activation model of word processing.

Extending this investigation of word differences to word learning in bilinguals, further work by Altarriba and Basnight-Brown (2012) examined abstract, concrete, and emotion words in Stroop and recognition tasks. In the Stroop task (in which participants are asked to name the typeface color of a presented word), participants responded faster to emotion words than abstract and concrete words, with no significant differences in accuracy across word types. In the recognition task, participants were asked to judge whether a pair of words were the correct translation between English and Spanish. The results revealed that concrete words elicited significantly faster reaction times (RTs) than emotion and abstract words, and correct responses for abstract word trials were significantly faster than those for emotion words. Finally, it was found that words paired with semantic foils (an incorrect word highly associated to the correct response) differed significantly from words paired with unrelated words across all three word categories on incorrect responses (Altarriba & Basnight-Brown, 2012). These results were presented in the larger context of second language acquisition, as the study found that the newly acquired second language emotion words were more slowly recognized than concrete or abstract second language words. This was attributed to the stronger encoding of emotion words and concepts in one's native language, largely due to the repeated exposure and context necessary to learn nuanced emotion categories (Herba et al., 2006; Widen & Russell, 2008).

Taken together, these studies provide considerable evidence supporting the differences between emotion, abstract, and concrete word types, and the importance of distinguishing between the three types of words when designing research. These differences are also proposed to be related to the way in which each of the word types is processed, with emotion words' increased imageability and context availability leading to differences in processing (Altarriba & Bauer, 2004; Pavlenko, 2008). These results on how emotion words are different from other word types is an important component of understanding how emotion words' characteristics impact their processing.

One model of emotion which helps contribute to our understanding of emotion word processing is the Circumplex Model of Affect (Russell, 1980). The Circumplex Model describes emotion word representation, and how emotion categories (linguistically represented) relate to one another, spatially. Russell (1980) explains that two major factors account for how people tend to characterize emotion words (and by extension, emotional states). These two bipolar dimensions are the pleasant-unpleasant (valence) dimension and the awake-sleep (arousal) dimension. These two dimensions have been tested and compared against a range of possible other factors in emotion representation, and although a number of other dimensions have been proposed (e.g., potency, dominance/submissiveness, approach/avoidance), the only additional dimension which has shown to have any significant impact on a model's ability to characterize emotion representation is the dominance/submissiveness dimension (Russell & Mehrabian, 1977). While this dimension was found to be a significant predictor of emotion representation by Russell and Mehrabian (1977), multiple studies (Citron, 2012; Feldman Barrett & Russell, 1998; Posner, Russell, & Peterson, 2005) have indicated valence and arousal as sufficient for the description of emotion representation.

Using valence as the horizontal dimension and arousal as the vertical dimension, most emotion words will fall fairly neatly onto a circle. This results in the following arrangement of emotion categories: arousal at 0°, excitement at 45°, pleasure at 90°, contentment at 135°, sleepiness at 180°, depression at 225°, misery at 270°, and distress at 315° (see an example in Figure 1). In Russell's (1980) work, participants were asked to categorize a list of words into a set of emotion categories which corresponded to eight emotional states falling on the circular extremes of the valence-arousal plane. Participants were also asked to place the same list of eight emotion categories into a circle, with proximity denoting similarity between categories and words opposite one another denoting opposing feelings. The results of these tasks showed remarkable consistency in participants' placements of the emotion categories spatially, replicating the predicted arrangements of emotion categories according to the Circumplex Model. Importantly, variance in the categorization task reflected the relatively "fuzzy" boundaries between emotion categories, with each emotion word used in the study sometimes falling into an adjacent category. Each emotion category had, as Russell (1980) describes it, a gradual, but specifiable transition from membership to non-membership for a given emotion word.

One of the main predictions from this arrangement of emotion categories is the idea that emotions which appear relatively close together on this plane (“upset” and “sad”, for example, both having a fairly extreme negative valence but “upset” with a higher and “sad” with a lower associated arousal), should be more closely related semantically, and therefore more strongly primed by one another. These predictions, however, have not been fully supported in literature looking at relationships between emotion words.

Interestingly, antonyms have been observed to exert priming effects on one another, which calls into question the applicability of the Circumplex Model in word processing domains (e.g., Altarriba & Bauer, 2004). The Circumplex Model does not contain a mechanism which readily explains the observed priming of antonym emotion words as reported by Altarriba and Bauer (2004). Altarriba and Bauer (2004) suggest that the semantic relationship between words like “happy” and “sad” was more relevant to processing on a semantic task than the emotional characteristics of those words, and the priming predictions made by word processing models seemed to be more relevant than those made by models of affect. This appears to be echoed in another of this study’s findings, wherein both emotion words and abstract words exerted priming effects on words of the same type, and abstract words were able to prime emotion words (but not the other way around) (Altarriba & Bauer, 2004). Taken together, observed semantic priming based on emotional characteristics, imageability, and context availability indicate not only the distinction between emotion, abstract, and concrete words, but also the relevance of semantic characteristics in the evaluation of emotion words.

Valence and Arousal

Valence.

Though a range of studies have looked at the differences between abstract, concrete, and emotional words, their findings have differed in the specific mechanisms used to explain the processing differences between these word types. Many studies have emphasized valence and arousal as key characteristics to explain observed processing differences in a range of tasks. Kahan and Hely (2008) looked at how emotional characteristics, as well as other lexical characteristics such as word length and orthographic neighborhood size (the number of other words which can be formed by changing one and only one letter in any given word, keeping all other letters in their same positions), contribute to RTs in a Stroop task. This study used a range of words normed for valence and arousal as well as word length, frequency, and orthographic neighborhood size. When controlling for the three non-emotional word characteristics mentioned, they found that frequency was related to performance on the Stroop task; however, valence also contributed to variance in RTs. A significant interaction effect was found between valence and word frequency, resulting in slower RTs for negatively-valenced low frequency words as compared to high frequency words (Kahan & Hely, 2008). Longer RTs for negatively-valenced words have also been reported by Estes and Adelman (2008). This work details the extent to which slower RTs can be seen across processing of negatively-valenced words, regardless the degree of negativity. In this way, attention paid to negative emotion words is largely consistent regardless of whether the word is slightly or intensely negative. These findings were expanded upon later in studies which looked at valence and arousal characteristics of emotion words in a LDT (Kousta et al., 2009; Vinson et al., 2014). Kousta et al. (2009) found that emotionally valenced words (whether positive or negative) were processed more quickly than neutral words, and verified this finding in a further regression analysis using word characteristics taken from the English Lexicon Project (ELP; Balota et al., 2007). Importantly, this analysis revealed that valence maintained a significant effect on lexical decision RTs even when the effects of other word characteristics (including arousal) were removed.

The importance of valence in processing was also corroborated by Kousta et al. (2011). In a series of experiments, Kousta and colleagues (2011) used a LDT to investigate differences in the processing of abstract and concrete words when a range of word characteristics were controlled for (including age of acquisition, word length, and number of orthographic neighbors). In Experiment 1, abstract words were responded to faster than concrete words. In Experiment 2, abstractness was isolated from valence of the words by repeating the same procedure with neutrally valenced abstract and concrete words. Isolating these characteristics resulted in no observed differences between abstract and concrete words, indicating that the valence of the previously examined abstract words were related to the faster RTs they elicited. Experiment 3 attempted to expand this finding by examining a larger set of words with a full range of valence and arousal characteristics, allowing other previously controlled for word characteristics to vary freely. This experiment found that RTs for abstract words were faster than those for concrete words, but there was no “abstractness effect” when affective characteristics were controlled between the word types (Kousta et al., 2011). Kousta and colleagues do not necessarily interpret these findings to necessitate the consideration of emotion words as a distinct category, but the combination of their findings with other supporting literature on the effects of emotional characteristics in word processing supports the distinction. Echoing this finding, a study by Kuperman, Estes, Brysbaert, & Warriner (2014) found that not only were negatively-valenced words processed more slowly than neutral words and positive words, but also that the valence of these words accounted for a significant amount of the observed RT differences when other lexical characteristics were controlled.

In an extensive review of theories and methodologies related to assessing the influence of emotional characteristics on attention, Yiend (2010) concluded that in the general population, emotional content in a stimulus draws attention more than a neutral stimulus, and this effect is particularly pronounced for negative emotional stimuli. In terms of mechanisms relevant to this effect of emotional content on attention, it has been suggested that the tendency to attend to negative stimuli has evolved over time and is beneficial to identifying potentially dangerous stimuli in the environment. A 2005 study by Lipp and Derakshan examined the connections between negatively-valenced (in this case, fear-evoking) images and attention using a dot-probe paradigm. Participants were shown a fear-relevant or fear-irrelevant picture in either the left or right hemifield, and would then respond to a dot appearing on either the same or different side from the picture displayed. The fear-relevant images resulted in faster probe detection as compared to fear-irrelevant images when displayed on the same side (Lipp & Derakshan, 2005). Related to the these findings, the automatic vigilance hypothesis states that negative stimuli are automatically attended to with attentional resources (Pratto & John, 1991). Experiment 1 of Pratto and John’s (1991) study looked at how a word’s valence would interfere with a color naming task, and found that negatively-valenced words elicited slower color naming times than the positively-valenced words. These effects were not found to be attributable to conscious processing on the part of participants. Experiment 2 investigated how valenced words might be more readily remembered (through incidental learning) after completing the same experimental procedure from Experiment 1. Experiment 2 replicated the color naming effects seen in

Experiment 1, and additionally found that negatively-valenced stimuli were recalled significantly more than positively-valenced stimuli.

It should be noted that categorical attention capture effects do not necessarily apply to conscious identification of an image's content. Becker (2012) explored how valence influenced the time required to identify the contents of an image. For Experiment 1, participants were shown a series of images for 60ms each, and each image was followed by a mask. Participants were tasked with remembering the presented images and recalling them for a memory task later on. After the initial presentation, participants were given a recognition test. Results of Experiment 1 indicated a significant effect of valence, with positive images being recognized better than negative images. In Experiment 2, participants were shown two images simultaneously for 30, 40, 50, 60, or 70ms, and tasked with making a response indicating whether the images displayed were the same. Analyses revealed main effects of presentation duration and valence, such that longer presentations and positive valence increased response accuracy. Using a similar procedure to Experiment 1, Experiment 3 sought to clarify the extent to which negative valence can impact processing of neutral images paired with negative images. This procedure was used to test two different hypotheses about the way in which negative valence impacts processing: (1) that the presence of a negative stimulus elicits a diversion of attention away from the stimulus, resulting in enhanced processing of the neutral stimulus, or (2) that negative stimuli elicit a global interruption in processing, resulting in reduced processing of the neutral stimulus. Though the effects of valence seen in Experiment 1 were replicated successfully, the pairing of neutral images with valenced images was not found to have a significant impact on the processing of the neutral images (Becker, 2012). Experiment 3 provided evidence against attention-based explanations of processing differences for negative stimuli. Overall, the results of this study indicate that positively-valenced images are more accurately recalled and more quickly identified than negatively-valenced images. These findings align at least partially with previous studies indicating enhanced recall and processing of valenced words. However, these findings do contrast with studies indicating increased attention paid to negative words (Estes & Aldeman, 2008; Kuperman et al., 2014) as well as different effects of valence on word and image processing (Sutton & Lutz, 2018)..

A recent meta-analysis of studies investigating valence and attention focused on the importance of looking at positively-valenced stimuli, as many previous studies had focused largely on negatively-valenced stimuli (Pool et al., 2016). The analysis found a significant bias towards positive stimuli. More in depth analysis revealed a larger portion of this effect occurs in studies investigating earlier attentional processing of positively-valenced stimuli, as opposed to later attentional processing. In addition, Pool et al. (2016) found that arousal was a significant predictor of attention when the positive stimulus was personally relevant to the participant (e.g., when it related to personally relevant concerns, such as hunger, security, or self-achievement).

The complexity of valence’s effects on stimulus processing has also been investigated in the context of response inhibition (Yang et al., 2014). Yang et al. (2014) used a go/no-go task, in which participants had to make or withhold a keypress response based on the valence of the stimulus presented. Stimuli consisted of a number of faces normed for valence and arousal, split up into blocks to balance which valence condition (positive, neutral, negative) would cue a go or no-go response. Electroencephalogram (EEG) measurements were taken during the task, and the primary measures of interest (besides reaction time and accuracy) were the N200 (associated with response inhibition, in this case no-go trials), P300 (indicative of motor inhibition and evaluation of inhibition outcome), and N170 (related to the presence of emotional content in faces) potentials. Analyses revealed that emotional faces elicited faster response times than neutral faces and that positive blocks had faster RTs than negative blocks. Overall, results indicated that emotional content in facial expressions impairs response inhibition, driven by increased processing of emotional information, as evidenced by decreased N200 and increased N170 amplitudes (Yang et al., 2014). These neural correlates of emotional word processing indicate, as much of the previously discussed research does, that valence's impact on processing is complex and depends on context in many cases. Overall, valence makes a stimulus more salient and makes it more likely to be processed or attended to faster than a non-emotional stimulus. Within this, negative stimuli tend to capture attention more automatically than positive stimuli and hold that attention for longer. The distinctness of these effects from differences caused by non-emotional characteristics, such as abstractness and imageability, again point to the importance of valence when a word is being processed.

Arousal.

Arousal has also been posited as an important characteristic that influences how one responds to a stimulus. Vogt, De Houwer, Koster, Van Damme, and Crombez (2008) raised the question of whether arousal, and not valence, drives attention to emotional stimuli. This study used a modified spatial cueing task, in which participants were tasked with accurately responding based on which side of the screen a target appeared. In each trial, participants were shown a cue, which would either validly or invalidly indicate which side of the screen the target would appear. Then, images normed for valence and arousal characteristics were displayed on both sides of the screen, with the target superimposed on one of the pictures, and participants made their response. Results indicated that RTs were significantly faster on validly cued trials, but there were no significant main effects of valence or arousal. There was, however, an interaction effect between validity and arousal level. RTs were significantly slower for high arousal stimuli on invalidly cued trials. These results led the authors to conclude that arousal was the driving factor impacting attention in this paradigm, as the patterns of RTs indicated slower attentional disengagement with high-arousal stimuli (Vogt et al., 2008).

Examining the role of arousal in stimulus processing from the neural level, Leite, Carvalho, Galdo-Alvarez, Alves, Sampaio, and Gonçalves (2012) used images normed for valence and arousal to analyze early posterior negativity (EPN, linked with early selective attention), late positive potential (LPP, related to initial and sustained processing of emotional content of a stimulus), and neural activity during an induced startle response. After analysis, the emotional stimuli produced larger EPNs than the neutral stimuli. Higher arousal images elicited larger LPPs, indicative of sustained processing. As far as startle response, there was a significantly lower potential amplitude for the positive valence and high arousal conditions as compared with all other combinations of arousal and valence. This reduced startle response for high arousal pictures was interpreted as indicating that arousal was a more relevant factor in attention and stimulus processing than valence, which did not show significant effects when considered with arousal (Leite et al., 2012). Characteristics such as arousal may impact processing at many stages, and with the use of ERP data we are able to see early effects of these characteristics alongside much later behavioral outcomes.

Arousal x Valence.

Larsen, Mercer, Balota, and Strube (2008) found a combined effect of arousal and valence in word processing. The researchers argued that previous work on the automaticity of attention to negatively-valenced stimuli was flawed because studies did not adequately control for lexical characteristics, which then become confounded with valence. The authors argued that proposed categorical negativity effects (Estes & Aldeman, 2008) are eliminated by controlling for valence and other word characteristics such as word frequency and variance in valence/arousal ratings (Larsen et al., 2008). Instead of categorical negativity, a more complex consideration of the relationship between valence, arousal, and other word characteristics is emphasized. Specifically, the authors concluded that the relationship between valence and RTs in lexical decision and naming tasks was not linear (as categorical negativity would imply), based on an interaction effect on processing speed between valence and arousal. Negative words low to moderate in arousal produced more of a slowdown in processing as compared to high arousal negative words, which the authors attributed to the increased salience and urgency of high arousal negative stimuli.

Sutton and Lutz (2018) used a dot-probe task to investigate the role of valence and arousal on attention. The dot-probe task in this study used emotional and neutral words and images presented to both the left and right halves of the visual field to manipulate attention, and a subsequent keypress task (identifying the letter presented) was used as the main reaction time measure. The study found that negative word stimuli resulted in faster RTs, regardless of the arousal level of the word, when the word was presented on the same side as the response-appropriate key (congruent trials). Positive words did not capture attention in a similar way. Negative images, and positive images high in arousal, elicited the same congruency effect observed with negative words, indicating enhanced attentional capture. Importantly, this result indicates that arousal, not just valence, is a relevant characteristic during image processing and subsequent task performance, at least for positively-valenced images (Sutton & Lutz, 2018).

Research looking at the respective roles of valence and arousal have shown varying effects according to experimental manipulation, task used, and extraneous lexical variables controlled for. Overall, current research points to (a) the importance of valence in word processing, (b) increased attention devoted to negative stimuli, as well as stimuli high in arousal, (c) the potential of arousal and valence to interact with other word characteristics depending on the task, and (d) the importance of considering the semantic and lexical characteristics of the stimuli used in research studies. What is not clear from the research discussed up to this point are the differences between emotional stimuli, specifically the way emotion-label and emotion-laden words are processed.

Emotion-label vs. Emotion-laden Words

Research into the differences between emotion-label and emotion-laden words is relatively new, and as such, only a handful of behavioral studies from a few main researchers have been conducted, namely Altarriba and colleagues. That being said, findings from Altarriba's lab have been replicated by other researchers, and several studies looking at emotion-label and emotion-laden word differences have only found differences in limited contexts. Though emotion words have been shown to constitute their own category distinct from abstract and concrete words, recent research points to the importance of further distinguishing between emotion-label and emotion-laden words. Emotion-label words refer to specific affective states, either in a descriptive (e.g., "she looks sad") or self-expressive (e.g., "I feel happy") manner, and have most commonly been the focus of studies looking at emotion word processing. Emotion-laden words do not refer to a specific affective state, but often express or elicit an emotional response (Pavlenko, 2008). Examples of emotion-laden words would be words such as "funeral", "creep", "sweetheart", and "birthday". These words have often been intermixed with emotion, abstract, and concrete words in previous research (Holtgraves & Felton, 2011; Inaba et al., 2007; Kanske & Kotz, 2007; Kuchinke et al., 2005), but their affective characteristics and associations have been the target of more recent research exploring how they are processed differently from emotion words.

In terms of lexical acquisition, emotion-laden words have to develop an association with a particular affective state, which takes repeated exposure and learning to solidify in the brain. One of the first studies to examine concrete differences in the processing of emotion-label and emotion-laden words used a Stroop task and examined the differences between these word types in both English (Experiments 1 and 2) and Spanish (Experiments 3 and 4) (Altarriba & Basnight-Brown, 2011). In their first experiment, Altarriba and Basnight-Brown (2011) examined English emotion-laden words in a Stroop task with monolingual English speakers. Participants were instructed to make one keypress response if the stimulus word was blue and a different response if it was green, or to respond based on the word's valence if the word was presented in white. Since only two keys were used as responses, each key would have two responses associated with it (e.g., positive valence and blue color), and the responses tied to each key were counterbalanced across participants. Experiment 1 indicated that emotion-laden words elicited an affective Simon effect similarly in both positively and negatively-valenced words in English monolinguals. In this study, the affective Simon effect refers to faster RTs when the appropriate response key for the color judgment matches the key used to indicate the valence (positive or negative) that matches the word presented. Experiment 2 in this study repeated the procedure used for emotion-laden words with emotion-label words, and found that only negative emotion-label words produced the affective Simon effects observed for both positive and negative emotion-laden words in Experiment 1. Further analysis of these congruency effects indicated a significant interaction between congruency, valence, and experiment, potentially due to the tendency of emotion-laden words to be more concrete than emotion-label words (Altarriba & Basnight-

Brown, 2011). Overall, emotion-label and emotion-laden words produced different patterns of Stroop effects, with emotion-laden words producing Stroop effects for both positive and negative words and emotion-label words only exhibiting these effects for negative words. These differences were attributed to the separation of emotion-laden and emotion-label words in this study, where these word types had been intermixed in similar previous studies.

Knickerbocker and Altarriba (2013) examined the differences between emotion-label and emotion-laden words using the rapid serial visual presentation (RSVP) paradigm. In this paradigm, a series of words are presented one at a time, and participants are asked to respond to a target word within that stream. In this case, emotion-label and emotion-laden words were used to examine the differences in repetition blindness across word type. Repetition blindness refers to poorer recall and recognition of words that appear multiple times and close together in a series or within a sentence. Previous studies looking at emotion words in this paradigm intermixed emotion-label and emotion-laden words. This study separated emotion-label and emotion-laden words, and only used words with negative valence and high arousal as well as a separate set of neutral words with moderate valence and low arousal. In the RSVP paradigm used in Experiment 1, each trial consisted of one or multiple target words presented for 90ms each in sequence. Participants had to report the sequence of presented target words, and the accuracy of their responses was the main measure of interest. Experiment 1 found a main effect of repetition across all three word types (emotion-label, emotion-laden, and neutral), indicating that repeated targets were recalled with lower accuracy than non-repeated targets, which aligns with the expected repetition blindness effect. In addition, there was a main effect of word type such that emotion-label words were recalled more accurately than either emotion-laden or neutral words on unrepeated trials, with emotion-laden and neutral words not differing from each other.

Analyses also revealed a significant interaction effect between word type and repetition, indicating again that emotion-label words exhibited a larger repetition blindness effect as compared to either emotion-laden or neutral words on repeated trials. The authors explained these seemingly contradictory results as stemming from the aggregation of repeated and unrepeated trials for the main effect of word type, resulting in higher overall recall accuracy of emotion-label words despite a larger repetition blindness effect seen on repeated trials (Knickerbocker & Altarriba, 2013). Experiment 2 used a similar RSVP paradigm, but altered the stimuli to assess the repetition blindness associated with emotion-label and emotion-laden words presented in full sentences. As in Experiment 1, all three word types exhibited a main effect of repetition, with repeated words being recalled less accurately. In Experiment 2, there was no significant main effect of word type, but the interaction between word type and repetition was significant. Specifically, emotion-label words were both more accurately recalled in the unrepeated trials as well as significantly less accurately recalled in the repeated trials when compared to emotion-laden and neutral words. Taken together, the results of this study replicate repetition blindness for emotion-label and emotion-laden words, and indicate that repetition blindness effects are significantly larger in emotion-label than emotion-laden or neutral words, even when arousal and valence are controlled for across words (Knickerbocker & Altarriba, 2013). Once again, the results of this study indicated that emotion-laden words should be considered distinct from emotion-label words.

Kazanas and Altarriba (2015b) used a LDT to assess both explicit and implicit processing of emotion-label and emotion-laden words. Experiment 1 measured explicit processing with both positively and negatively-valenced emotion-label and emotion-laden words in a LDT. After being presented with a prime word (either positive or negative and either emotion-label or emotion-laden), participants were tasked with judging if a subsequently presented target (which was either related, unrelated, or a nonword) was a word or nonword. All related word pairs created were of the same type (emotion-label only or emotion-laden only), and valence of the words was manipulated. Arousal was controlled for, with all words similarly high in their arousal. Analyses revealed shorter reaction time for targets related to the primed word, as would be expected. Emotion-label words elicited the shortest RTs, and a similar effect was seen for positively-valenced words. An interaction between prime, valence, and word type also indicated that the shortest RTs occurred for positive, related, emotion-label target words, and the slowest times for negative, unrelated, emotion-laden target words (Kazanas & Altarriba, 2015b). Experiment 2 utilized a masked priming procedure to examine implicit processing of the stimuli, as a mask prevents conscious recognition of a priming stimulus. In each trial, a 50ms presentation of the prime word was immediately followed by a 200ms masking stimulus before the presentation of the target word, for which participants would again make a word or nonword judgment. This experiment replicated the effects obtained in Experiment 1, showing significantly faster RTs for emotion-label words and positive words, as well as the interaction between relatedness, word type, and valence, resulting in the shortest RTs for related, positive emotion-label words and longest for unrelated, negative emotion-laden words. The replication of these findings with a masked priming procedure is important as it minimizes the potential for explicit processing or strategizing by participants during the experiment (Kazanas & Altarriba, 2015b). Overall, this study found consistently slower processing for negatively-valenced stimuli as well as more accurate judgments for positive stimuli. These effects are attributed to the attention paid to positive versus negative stimuli, with a higher tendency to avoid negative and engage with positive stimuli. These findings indicate the relevance of valence and word type and their combined impacts on word processing.

Building on these findings and integrating them with previous work, another study by Kazanas and Altarriba (2015a) examined the differences between emotion-label and emotion-laden words in Spanish-English bilinguals using a masked priming LDT. The study found that emotion-label words elicited faster response times than emotion-laden words. In addition, the main effect of word valence was significant for both English and Spanish, resulting in faster RTs for positive words (Kazanas & Altarriba, 2015a). Overall, these findings suggest that the main effect of valence on word processing is present across both English and Spanish in English dominant bilinguals (Kazanas & Altarriba, 2015a). This finding is especially interesting given that the participants weren't equally fluent in their use of English and Spanish, meaning that word type differences were robust regardless of how heavily participants relied on English or Spanish in their regular lives.

In addition to behavioral studies, many recent studies examining the difference between emotion-laden and emotion-label words have focused on the neural correlates of word processing, including lateralization and event-related potentials. In terms of looking at emotion processing differences in the brain, there are two main hypotheses regarding lateralization based on valence. Some studies have suggested that the right hemisphere is primarily responsible for processing both negative and positive affect (right hemisphere hypothesis); (Borod et al., 1998; Hugdahl, 1995; Killgore & Yurgelun-Todd, 2007), while other researchers suggest that the left hemisphere plays a larger role in processing positive affect and the right hemisphere is more specialized for negative affect (valence specific hypothesis); (Adolphs, 2001; Ahern & Schwartz, 1979; Killgore & Yurgelun-Todd, 2007; Stalans & Wedding, 1985). Killgore and Yurgelun-

Todd (2007) presented participants with faces displaying two affective states, one on either side of the face (one half of the face happy or sad and one half neutral) while neural imaging techniques were used to capture brain activation during emotion processing. The results of these tests demonstrated overall greater right-hemisphere activation for the affective tasks used, regardless of valence and hemifield presentation, which supports the right hemisphere hypothesis. The results also indicated that certain combinations of stimulus characteristics (namely affective faces in the right visual field) resulted in more lateralized activity in the left hemisphere, supporting to a limited extent the valence specific hypothesis. Further investigating the hemispheric differences in emotion-related processing, Martin and Altarriba (2017) used a LDT to assess lateralization differences when processing emotion-label and emotion-laden words. Emotion-label and emotion-laden words with either positive or negative valence, as well as neutral words were presented to either the left or right hemifield, and RTs were recorded for the LDT on each trial. The results revealed main effects of word type and hemifield resulting in slower RTs for negative words than for positive words, and overall slower RTs for stimuli presented in the left hemifield. These results are consistent with language processing occurring more in the left hemisphere, as well as the right hemisphere’s proposed role in emotion processing over the left hemisphere. The authors noted that emotion-label and emotion-laden words did not produce significant differences, but this may simply be an artifact of the specific paradigm used and that emotion-laden words may not be processed differently in different hemispheres of the brain (Martin & Altarriba, 2017).

Zhang, Meng, Wu, and Yuan (2017) examined the neural differences between processing of emotion-label and emotion-laden words. This study once again made use of a LDT, and used EEG measurements of the P100, N170, and Late Positivity Complex (LPC) ERPs. The P100 corresponds to attention biases towards emotion words and generally has a higher amplitude for negative words. The N170 reflects the differentiation of emotional and non-emotional content when processing a word, and tends to have a larger amplitude for positive and negative words than for neutral words. Finally, the LPC is related directly to the emotional characteristics of a particular stimulus, especially valence, and indicates dedicated processing to the emotional components of the stimulus (Citron, 2012; Zhang et al., 2017). The authors found that, while no significant differences were found in the P100 measurements across word type or valence, emotion-label words elicited a larger right hemisphere N170 and negative words elicited a larger LPC than positive words. This difference indicates a potential increase in processing of emotional content for emotion-label words compared to emotion-laden words. In addition, an interaction between word type, valence, and hemisphere indicated that negative emotion-label words elicited a larger LPC in the right hemisphere as compared to the left, pointing to more processing of valence in the right hemisphere (Zhang et al., 2017). These results indicate that differences in how emotion-label and emotion-laden words are processed can be found even at the neural level, which has also been examined in a number of other ERP studies (Wu et al., 2019; Zhang et al., 2018; Zhang, Teo, et al., 2019; Zhang, Wu, et al., 2019).

The range of findings regarding the processing differences between emotion words and abstract/concrete words, as well as the differences within the broader emotion word category highlight the complexity of considering emotional characteristics in word recognition and processing. This is partially due to the fact that the distinction between emotion-label and emotion-laden words has only recently been researched, and raises the question of how the relationship between emotion-laden and emotion-label words may be better understood. One paradigm which should be able to characterize the associations between emotion-label and emotion-laden words is the semantic satiation paradigm.

Semantic Satiation

Many of the studies investigating the differences between emotion-label and emotion-laden words have utilized the LDT. Tasks based on semantic characteristics have been less relied upon in previous work with emotion-label and emotion-laden words., and as a result, one goal of the present study is to assess how semantic differences between emotion-label and emotion-laden words may affect how they're processed. Of particular interest in assessing these differences is the semantic satiation paradigm, which allows for the manipulation of semantic elements of a word. Semantic satiation occurs when a given word is repeated many times over a short period, which negatively impacts the availability of the word's semantic features. This effect has been investigated across a number of different modalities and tasks, including facial recognition (e.g., Lewis & Ellis, 2000), lexical decision (e.g., Cohene, Smith, & Klein, 1978; Smith, 1984), and emotion categorization (e.g., Lindquist, Feldman Barrett, Bliss-Moreau, & Russell, 2006).

The proposed mechanism by which semantic satiation occurs is spreading activation, which is also responsible for semantic priming effects. Spreading activation is the increase in activity within associative pathways between a word and its meaning, and often the associative pathways of semantically related words as a result (Lindquist et al., 2006). These pathways may or may not be located close together in the brain, and the specific neural mechanisms underpinning spreading activation are not well studied (Posner & Carr, 1992). It is thought that activating these semantic pathways by repeatedly accessing the connection between a word and its meaning bogs down the connection itself, making subsequent judgments related to the given lexical entry more difficult. Tian and Huber (2010) looked to test several accounts of semantic satiation (e.g., associative satiation, meaning satiation, and lexical satiation) and at what level satiation effects occur. In four experiments using a series of modified satiation paradigms, the authors ruled out different explanations for semantic satiation effects, and concluded that associative satiation (wherein satiation occurs in the association between a word and its meaning) was the main mechanism behind the observed satiation effects (Tian & Huber, 2010). The reduction in the availability of meaning is thought to be related to the opposite effect, repetition priming, via the same mechanism of spreading activation. Jakobovitz and colleagues (Jakobovits & Hogenraad, 1967; Jakobovits & Lambert, 1962) interpret these two seemingly contradictory effects by applying a kind of inverted u-shaped frequency law to the number of repetitions a word undergoes versus the level of activation the word’s meaning undergoes, wherein zero and very high number of repetitions will result in a low accessibility of meaning and a low or moderate number of repetitions will increase availability.

Satiation paradigms have been widely used to investigate how word categories relate to one another and how satiating a certain word or word category impacts subsequent performance in a particular task. One study which provides a fairly typical procedure for a satiation-based experiment was conducted by Smith and Klein (1990) and specifically used a category membership task. In this procedure, a word (a category name, in this case) to be primed or satiated would be repeated by participants either 3 (for repetition priming condition) or 30 (for semantic satiation condition) times, and the participants would then be shown a word pair. The words in the pair would either be members or nonmembers of the satiated/primed category, and would be members of the same or different category to the other word in the pair. Participants were instructed to respond as quickly and accurately as possible to the relationship between the two words in the pair, and their RTs were the main dependent variable of interest (Smith & Klein, 1990). Satiation effects were observed where participants were slower to respond when the words presented were members of the satiated category, indicating that when the category was satiated its meaning was made temporarily less accessible. Very similar paradigms were utilized by Balota and Black (1997), who found that satiation effects were lesser for older adults than for younger adults (Kounios et al., 2000; Tian & Huber, 2010). Kounios et al. (2000) looked at satiation of visually, as well as auditorily, presented words, and how these different manipulations would impact neural-level processing in the form of ERP data. The authors found that within-modality satiation for both visual and auditory stimuli, as well as changes in the N400 ERP during semantic satiation, support the idea that semantic satiation is based in semanticity and not just perceptual adaptation.(Kounios et al., 2000).

The satiation paradigm has also been utilized to examine how emotion words are processed. Lindquist et al. (2006) looked at whether emotion-label words could be satiated to impact the ability of participants to categorize emotion displayed on faces. Much like in previous studies, the emotion-label word to be satiated was repeated either 3 or 30 times, followed by an image of a face displaying a particular emotional state. Participants were found to be less able to categorize a face displaying an emotion which had been satiated, as well as less accurate in making non-emotion related judgments about the face (e.g., distance between eyes) when the face displayed the satiated emotion (Lindquist et al., 2006). This study is one of the only studies to look at satiating emotion words, and the study only looked at emotion-label words as stimuli. This leaves a gap in current research as to whether emotion-laden words may be processed differently in this paradigm, and what characteristics may account for differences in processing.

The Current Study

Literature on word recognition and subsequent higher level processing lays a foundational understanding of how a word's characteristics can impact how it is processed, and also points to gaps in understanding the mechanisms behind these processing differences. Building on previous research demonstrating processing differences between emotion-label and emotion-laden words as well as positive and negative emotional words, the present study sought to further characterize the emotional characteristics of these words and their effects on processing. Using a semantic satiation paradigm allowed for this relationship to be characterized at a valence-category level, contributing to our understanding of what semantic characteristics can be manipulated, and how linguistic emotion categories relate to the words they are associated with. One of the main questions the present study sought to answer is whether a valence category itself can be manipulated, and how this may contribute to PDP models of word processing. The present study used emotion-label, emotion-laden, and neutral word stimuli with known valence and arousal ratings in a satiation paradigm using the paired valence match task, which was created for this study.

The paired valence match task was created to allow for the unique combination of variables in the present study, including word type, valence, and semantic manipulation via the satiation procedure. Moreover, previous findings about potential differences in emotional characteristics' impacts on word and image processing made it preferable to only use one modality or another for the task. The task itself consisted of the simultaneous presentation of two words, known as pair word 1 and pair word 2, respectively. The words were presented one slightly above the middle of the screen and one slightly below. These words were either positive, negative, or neutral, and were either emotion-label, emotion-laden, or neutral as well. Manipulating these characteristics allowed for detailed control and assessment of the relationship of the pair words to the target (primed or satiated) word. For the task, participants had to read both words silently, decide if each word was positive, negative, or neutral, and finally respond via keypress whether the valences of the pair words were a “match” or “mismatch”.

This approach to assessing valence was a more appropriate one than other common word-based tasks, as it relies on evaluating the meaning of the stimuli as well as allows for variation in word type. Other category-membership based tasks may have worked well for emotion-label and even neutral words, but simply asking if “birthday” is in the same category as “happy” was expected to be problematic. Participants could evaluate the two words and their relationship on any number of characteristics, including valence, word type, part of speech, or even whether the word is a compound word or not. To avoid confusing participants as well as to not rely on the participants remembering what the primed or satiated word was to complete the task, participants were instructed to not consider the target word in their subsequent task response, and only had to evaluate the pair words on whether they had the same valence or not.

In a pilot study assessing the task and overall experimental design, participants were given 2s to make their responses in the task. This seemed to be too short a window for most participants, and the rate of trials on which no response was made before the 2s window was up was relatively high. Extending this window to 3s allowed more time for participants to complete the relatively complex task, and resulted in a much lower incidence of missed responses.

Hypotheses

Manipulating the availability of a word’s meaning via satiating and priming procedures has consistently been shown to have an impact on processing that word. In accordance with previous research (Cohene et al., 1978; Pynte, 1991; Smith & Raygor, 1956; Smith, 1984; Smith & Klein, 1990), it was expected that satiating a word's meaning would make it less accessible, resulting in longer RTs in making the valence judgment, and priming its meaning would result in shorter RTs, reflecting an increased availability (H1). Overall, previous literature emphasizes the influence of a word's valence on word processing over its arousal (Estes & Adelman, 2008; Vogt, et al., 2008; Yeind, 2010), and based on this valence was considered a main variable of interest. It was expected that words with negative valence would elicit slower RTs in the satiation/priming paradigm as compared to positive words (H2). The difference in processing of emotion-label and emotion-laden words has been demonstrated in a number of paradigms (Altarriba & Basnight-Brown, 2011; Knickerbocker & Altarriba, 2013; Kazanas & Altarriba, 2015b), and these studies have generally shown reduced effects for emotion-laden words as compared to emotion-label words. In the present study, it was expected that these findings would be replicated (H3). Further, including neutral words allowed for comparisons of the effect of valence and word type to a reference level, which is both neutral in valence and word type. It was expected that emotion-laden words would exhibit greater priming and satiation effects than neutral words (H4).

Method

Participants

Participants were 71 undergraduate students enrolled in psychology courses at Rochester Institute of Technology, mostly recruited through RIT's SONA study participation system. Two of the 71 participants were recruited through flyers posted around campus and were incentivized with entry into a raffle for one of two $25 Amazon gift cards, funded through the College of Liberal Arts Student Research Funding program. The other 69 participants received study participation credit via SONA. Participants ranged from 18 to 25 years old (*M*=19.30, *SD*=1.51), with 60.3% being female (n=43), 38.3% male (n=27), and 1.4% non-binary (n=1). Eleven percent of participants were left handed (n=8), 88.9% right handed (n=63), and 2.8% of participants were Deaf or hard-of-hearing (n=2) with the remining 97.2% responding they were hearing (n=69). All participants were native English speakers with normal or corrected-to-normal vision. Participants were screened with the Beck Depression Inventory (BDI-II; Beck, Steer, & Brown, 1996) and the State-Trait Anxiety Inventory(STAI; Spielberger, Gorsuch, & Lushene, 1970), to control for potential divergent processing of emotional stimuli. Previous studies (Leppänen, 2006; Trippe et al., 2007) have indicated a bias towards negative responses in individuals with major depressive disorder and other mood disorders, stemming from changes in how emotional stimuli are processed. All participants were included in the analyses regardless of mood state inventory scores, but participants scoring above 13 on the BDI-II or above 43 on the STAI were considered as their own groups, to assess the role mood state plays in word processing. Additionally, the two Deaf/Hard-of-hearing participants had significantly longer RTs in the experimental trials and were therefore excluded from analyses.

Independent Variables

In the present study, the independent variables were (1) valence congruency, defined as the valence of the target word on any given trial, coded together with whether that valence was shared between the target and one or more pair words (congruent) or not shared (incongruent); (2) target word type, defined as the word type of a given target word (emotion-label, emotion-laden, or neutral); (3) satiation condition, defined as whether a given target word was repeated 3 (primed) or 30 (satiated) times; and (4) mood state, which was defined as the combination of scores from the BDI-II and STAI inventories, which measured depression and anxiety, respectively. Those participants scoring above clinical thresholds on either inventory were considered “scoring” on that inventory, and were analyzed in groups based on these scores. Additionally, auxiliary analyses included pair match/mismatch as an independent variable, which was defined as whether the two pair words on any trial had matching or mismatching valences.

Dependent Variables

The main dependent variable in the present study was reaction time in the paired valence match task, which was defined as the time it took for participants to make a keypress response in the task. Each set of 3 or 30 word repetitions was followed by the paired valence match task, altogether constituting one trial. Additional dependent variables included participant response rate, defined as the proportion of trials on which some response was made, regardless of whether it was a correct response; and accuracy, which only considered trials on which a response was made and which was defined as the proportion of correct responses therein on trials where some response was made. For all analyses, only the reaction times for correct responses were considered unless otherwise indicated.

Materials

Words used for stimuli in the present study were drawn from the Affective Norms for English Words corpus (ANEW, Bradley & Lang, 1999). All words in this corpus have been normed for valence, arousal, and dominance using the Self-Assessment Manikin (SAM) procedure (Bradley & Lang, 1994). This procedure asks participants to rate a given word using pictorial representations of valence, arousal, and dominance scales. For the ANEW corpus, these scores were then aggregated and reported for the entire group as well as split by gender. Words used included emotion-label, emotion-laden, and neutral words, all selected to have similar arousal ratings, word length, and word frequency. These additional word characteristics were taken from the English Lexicon Project, which contains ratings of a range of lexical characteristics for English words, including word length, orthographic neighborhood size, frequency, and other phonological/morphological characteristics (ELP; Balota et al., 2007) (see Appendix 1). The words varied in valence, with either positive (e.g., “happy”, ”party”, with scores ranging from 7-9), negative (e.g., “angry”, “gloom”, with ranging from 1-3), or neutral (e.g., “finger”, ”glass”, with ranging from 4-6) ratings. Neutral words were included to compare the effect of valence between emotion-label and emotion-laden words. According to a spreading activation model of satiation, repeating a neutral word 30 times should not influence RTs in the evaluative task, while satiating an emotion word should slow RTs. Mood state inventories included the Beck Depression Inventory (BDI-II; Beck et al., 1996), which consists of 21 questions used to assess for the presence and severity of depressive symptoms, as well as the State-Trait Anxiety Inventory (STAI; Spielberger et al., 1970), which consists of 40 questions assessing for state and trait anxiety in adults.

Design

The present study used a mixed design, with valence (positive or negative, with neutral words being presented to all participants) as a between-subjects factor and target-pair congruency (congruent or incongruent), semantic manipulation (satiation or priming), and target word type (emotion-label, emotion-laden, or neutral) as within-subjects factors. Stimulus blocks were separated by word type and valence (positive and negative emotion-label, emotion-laden, and mixed word type pairs) based on previous studies which have separated positively and negatively valenced stimuli to eliminate carryover effects between trials using different valences (e.g., Kazanas & Altarriba, 2015b). Neutral targets were separated into their own block and presented to all participants. For example, a participant might be presented with a neutral block, followed by a positive emotion-label word block, positive emotion-laden word block, and a positive mixed pair block. This resulted in four experimental blocks per participant, each with 20 trials. Trials were evenly split between match or mismatch word pairs and satiation or priming semantic manipulations. Mood state was included as an additional between-subjects grouping variable, resulting in participants being split up into a number of mood state groups after their data were collected.

Procedure

All participants were tested individually in a laboratory on the Rochester Institute of Technology campus. All participants completed written informed consent paperwork as well as a brief demographic questionnaire, noting age, hearing status, handedness, and gender. Participants were seated a comfortable distance from a 21.5 inch iMac computer with keyboard and mouse. The satiation portion of the experiment was presented via SuperLab 4.5 software (Cedrus Corporation, 2007). Participants first completed a block of six practice trials to familiarize themselves with the experimental setup before moving on to the main four blocks of experimental trials. Each trial began with a fixation cross displayed in the middle of the screen for 1 second, followed by the appearance of the primed/satiated word in place of the fixation cross. Each word exposure lasted 500ms and was followed by a 200ms display of a fixation cross in place of the word. Participants were instructed to say aloud the displayed word clearly either 3 (for priming condition) or 30 (for satiation condition) times, once for each time it appeared on screen. Participants were not explicitly told how many times they would be repeating each word. A sample trial is shown in Figure 2.

Upon completion of the requisite number of repetitions, a fixation cross appeared again for 1s, serving as a cue that the paired valence match task would follow. Word pairs replaced the fixation cross after the 1s cue period, with one word appearing above and one word below the former position of the cross. Words remained on screen until a response was made up to 3s, and all words used were in lowercase typeface. The task required a judgment of whether the two words displayed were of the same emotional valence as one another, with the “z” key indicating a matching valence pair and the “/” key indicating a mismatched valence pair. Participants were instructed to make the appropriate keypress response as quickly and accurately as possible. Participants were informed at the beginning of their session which two keys would signal the match and mismatch responses, and were reminded of the task instructions between each block of trials. Each participant completed a total of four blocks (neutral word block followed by emotion-label, emotion-laden, and mixed word pair blocks of the same valence), with the response keys remaining the same across all blocks for each participant. Participants then rated the words presented in the satiation/priming section of the study on their arousal and valence, using the Self-Assessment Manikin (SAM) rating scale, administered again on the iMac. This scale uses scales of human-like figures with a range of facial expressions, representing valence, arousal, and dominance. SAM scales do not use words or numbers to rate target words, instead relying on the representations of these emotional characteristics (Bradley & Lang, 1994). Upon completion of all experimental trials and SAM ratings, participants completed the BDI-II and STAI inventories. The entire experimental session lasted approximately 45 minutes, and a researcher was present for all participants’ sessions, to ensure the participants were engaging in the task appropriately and to answer any questions.

Results

Data Preparation

The present study consisted of three main sections, each delivered via a different program or modality. Reaction time and other trial data from the semantic satiation paradigm were recorded and exported via SuperLab software, Self-Assessment Manakin rating data were captured via Qualtrics survey software, and BDI-II and STAI scores were captured via paper copies of these inventories. Prior to analysis, both the satiation and SAM rating data were exported from their respective software in the form of one or more csv files, while the BDI-II and STAI data were first entered by hand into an Excel spreadsheet before being scored by spreadsheet formula. All three of these data types were then imported, formatted, and merged into several main data tables using R software, each table formatted for a specific set of analyses. As a part of this process, columns and rows which were exported by SuperLab or Qualtrics but were not necessary for analyses were removed. Additionally, any responses with an RT less than 500ms as well as trials which did not correctly record RT values in SuperLab were removed from the data tables prior to analyses. The full process of data import, formatting, and analysis is available in R scripts supplemental to this paper.

After preliminary assessment of the data via calculating accuracy response accuracy and response rate figures for each participant and each trial, four out of the total 140 unique trials were excluded from all analyses based on an apparent error in SuperLab or the initial coding of the experiment wherein responses were not recorded for these trials. The six practice trials at the beginning of each experimental run were also removed from the data for all analyses. There was no missing data in the SAM rating or demographics data captured via Qualtrics, nor was there missing data from the BDI and STAI inventories. The only missing data in the satiation paradigm data were the trials on which no task response was made, which were originally coded as 0’s by SuperLab but were converted to NA and marked as “NR” for “no response”, to prevent skewing of the RT data from zeros where there was no response made. All analyses were conducted via a combination of RStudio (RStudio Team, 2015), JASP (JASP Team, 2019), and jamovi software (The jamovi Project, 2019), the latter two of which both run on R code environments.

Descriptive Statistics

Overall response rate for the task was 98.2%, with 68.9% of all trials correct, 29.3% incorrect, and 1.8% no response. Participant response rates ranged from 73.75% to 100% (*M*=98.2%, *SD*=3.78%), while accuracy ranged from 57.63% to 83.33% (*M*=70.17% *SD*=5.39%) when a response was made. Average reaction times for each participant ranged from 947ms to 2098ms (*M*=1436, *SD*=277.56). Average reaction time was 1445ms (*SD*=474.6).

Main Analyses

To assess the main hypotheses laid out in the present study, a repeated measures analysis of variance was conducted, using satiation condition (primed or satiated) and word type excluding neutral (emotion-label or emotion-laden) as within-subjects factors, and valence excluding neutral (positive or negative) as the between subjects factor. Including incongruent trials induced an imbalanced group structure which prevented the analysis from being conducted, and as such, only congruent trials were included in this and subsequent repeated measures analyses. The Holm and Huynh-Feldt sphericity corrections were used to adjust df and p-values where it was found the ANOVA assumption of sphericity had been violated. These corrections were used to adjust for multiple comparisons and avoid inflation of significance test values in repeated measures tests (Field, 2017; Maxwell, 1980).

There was a significant main effect of priming/satiation ($F(1,68)=6.57$, $p<.05$, $\eta^2_p=.088$) (see Figure 3), as well as a significant interaction between word type, priming/satiation, and valence ($F(1,68)=14.28$, $p<.05$, $\eta^2_p=.174$) (see Figure 4). Post-hoc tests for the 3 way interaction indicated that primed, positive, emotion-laden words elicited significantly faster RTs than negative, emotion-laden, satiated words ($t=-4.038$, $p<.05$), though all other comparisons were non-significant at $p>.05$. Planned comparisons testing the main hypotheses in the present study were conducted. A planned contrast t-test to examine the difference between RTs for emotion-label ($M=1386$, $SD=309.79$) and emotion-laden ($M=1408$, $SD=302.15$) words indicated no significant difference between these two word types, ($t(68)=1.11$, $p=.269$), In addition, a t-test was conducted to compare RTs between the positive and negative words. No difference between participants in the positive ($M=1400$, $SD=292.36$) and negative ($M=1395$, $SD=245.10$) trial conditions was found, ($t(68)=.07$, $p=.941$). The planned contrast between primed ($M=1375$, $SD=286.87$) and satiated ($M=1419$, $SD=325.07$) reaction times was significant ($t(68)=2.56$, $p<.05$).

A subsequent repeated measures ANOVA which included neutral words was conducted to further assess word type and valence effects as they relate to the hypotheses in the present study. In this analysis, there was a significant main effect of word type ($F(1.698,115.492)=35.278$, $p<.05$, $\eta^2_p=.342$) (see Figure 5), a significant interaction of word type and priming/satiation ($F(1.864,126.755)=4.938$, $p<.05$, $\eta^2_p=.068$) (see Figure 6), and a significant interaction between word type, priming/satiation, and participant group ($F(1.864,126.755)=5.969$, $p<.05$, $\eta^2_p=.081$) (see Figure 7). Planned comparisons assessing the hypotheses in the present study indicated that neutral words ($M=1604$, $SD=443.67$) elicited significantly longer reaction times than either emotion-label ($M=1334$, $SD=442.04$) or emotion-laden (M=1338, SD=456.87) words (t(136)=7.654, p<.05). Other planned comparisons indicated that there was no significant difference between primed (M=1352, SD=454.71) and satiated (M=1379, SD=458.16) trials (t=.989, p=.326), nor was there a significant difference between participants in the positive trial group (M=1370, SD=459.36) and the negative trial group (M=1364, SD=447.225) (t=.381, p=.704). Post-hoc tests on the interaction between word type, priming/satiation, and participant group revealed that for participants seeing positive trials, primed emotion-label words elicited faster reaction times than primed neutral words (t=-6.406, p<.05) and satiated neutral words (t=-5.304, p<.05). Additionally, satiated emotion label words were faster than both primed neutral words (t=-4.716, p<.05) and satiated neutral words (t=-3.994, p<.05). For participants in the negative trial group, primed emotion-label words were faster than primed neutral words (t=-4.841, p<.05) and satiated neutral words (t=-3.660, p<.05), and primed emotion-label words were faster for participants in the negative group than primed neutral words for participants in the positive group (t=-3.669, p<.05). Finally, for participants in the negative trial group, primed emotion-label words were faster than satiated emotion-label words (t=-4.038, p<.05). These interactions can also be seen in Figure 7.

Originally, the BDI and STAI were included to provide a measure of mood state which could be used to exclude participants scoring above clinical threshold, to control for potentially divergent processing of negative words in the satiation portion of the experiment. After collecting the data from these inventories, it was found that a large portion of the sample scored above clinical threshold on one or more of the measures (BDI only=19.7%, STAI only=11.3%, BDI & STAI=12.5%, Non-Scoring=56.5%). It was decided that all participants would be included, adding mood state as a fourth factor in the analyses rather than excluding participants based on their scores. In terms of coding this factor, there were a number of viable approaches, but for the main analyses, mood state was coded as a binary factor based on whether a given participant scored above threshold on the BDI or not. Further examination of these different coding methods will be reviewed later in the discussion of mood state effects.

Mood state as measured by BDI score was also included in an additional repeated measures ANOVA with the aforementioned variables. This analysis again revealed a significant main effect of priming/satiation ($F(1,66)=5.89$, $p<.05$, $\eta^2_p=.082$) (see Figure 8) and interaction between word type, valence, and priming/satiation ($F(1,66)=12.48$, $p<.05$, $\eta^2_p=.159$) (see Figure 9). Planned contrasts run in this analysis indicated similar results to analyses not considering BDI score, with a significant difference between primed ($M=1375$, $SD=286.87$) and satiated ($M=1419$, $SD=325.07$) response times ($t(66)=2.43$, $p<.05$) and no significant differences between emotion-label ($M=1386$, $SD=309.79$) or emotion-laden ($M=1408$, $SD=302.15$) words, positive ($M=1400$, $SD=292.36$) or negative ($M=1395$, $SD=245.10$) trial group, or scoring ($M=1416$, $SD=451.45$) or not scoring ($M=1344$, $SD=457.40$) on the BDI. Post-hoc tests indicated the same significant contrast from the previous analysis ($t(66)=-3.89$, $p<.05$), though again all other comparisons were non-significant at $p>.05$.

The repeated measures ANOVA which included neutral words and BDI scoring showed a significant main effect of word type ($F(1.703,123.476)=31.521$, $p<.05$, $\eta^2_p=.323$) (see Figure 10), a significant interaction of word type and priming/satiation ($F(1.871,123.476)=4.702$, $p<.05$, $\eta^2_p=.067$) (see Figure 11), and a significant interaction between word type, priming/satiation, and participant group ($F(1.871,123.476)=4.868$, $p<.05$, $\eta^2_p=.069$) (see Figure 12). Planned comparisons assessing the hypotheses in the present study were similar to previous analyses, with neutral words ($M=1604$, $SD=443.67$) eliciting significantly longer reaction times than either emotion-label ($M=1334$, $SD=442.04$) or emotion-laden ($M=1338$, $SD=456.87$) words (t(132)=7.263, *p*<.05). Other planned comparisons indicated that there was no significant difference between primed (*M*=1352, *SD*=454.71) and satiated (*M*=1379, *SD*=458.16) trials (t=.989, p=.326), nor was there a significant difference between participants in the positive trial group *(M*=1370, *SD*=459.36) and the negative trial group (*M*=1364, *SD*=447.225) (t=.381, p=.704). There was also no significant difference in participants scoring (*M*=1385, *SD*=438.05) and not scoring (*M*=1314, *SD*=452.83) on the BDI. Again, post-hoc testing on the interaction between word type, priming/satiation, and participant group revealed a number of significant differences, which can be seen in Figure 12. Namely, for participants in the positive trial group, primed emotion-label words were faster than primed neutral words (*t*=-5.984, *p*<.05) and satiated neutral words (*t*=-4.817, *p*<.05). Participants in the positive trial group also had faster reaction times for satiated emotion-label words than for primed neutral (*t*=-4.339, *p*<.05) or satiated neutral (*t*=-3.481, *p*<.05) words. Additionally, primed emotion-laden words were faster than both primed (*t*=-4.449, *p*<.05) and satiated (*t*=-3.380, *p*<.05) neutral words, and satiated emotion-laden words were faster than either primed (*t*=-5.027, *p*<.05) or satiated (*t*=-4.193, *p*<.05) neutral words for participants in the positive trial condition. For participants in the negative trial group, primed emotion-label words were faster than primed neutral (*t*=-4.722, *p*<.05) and satiated neutral (*t*=-3.607, *p*<.05) words, as well as faster than primed neutral (*t*=-4.214, *p*<.05) and satiated neutral (*t*=-3.562, *p*<.05) words in the positive trial condition. Participants in the negative trial group had faster reaction times for satiated emotion-label words as compared to primed neutral words in both the negative (*t*=-4.106, *p*<.05) and positive (*t*=-3.951, *p*<.05) trial groups. Primed emotion-laden words in the negative trial group were faster than satiated emotion-laden words (*t*=-3.576, *p*<.05), as well as primed neutral words in the negative trial condition (*t*=-5.221, *p*<.05), primed neutral words in the positive trial condition (*t*=-4.489,

$p<.05$), satiated neutral words in the negative trial condition ($t=-4.090$, $p<.05$), and satiated neutral words in the positive trial condition ($t=-3.837$, $p<.05$).

As an exploratory analysis, a stepwise regression was conducted on key variables in the dataset, including the mood state inventory scores, valence ratings pulled from ANEW, word type, and priming/satiation. This regression analysis indicated that, while BDI score, STAI score, and Target Word Type were the best predictors of reaction times (all $p<.05$), the resulting model accounted for very little variance in the data, with a pseudo-$R^2<.01$). The results of this stepwise analysis can be seen in the included R scripts, but because the variables used did not produce good model fit overall, the contribution of this regression to the overall findings of the present paper are minimal.

SAM Rating Analyses

Once all participant SAM ratings for the words used in the satiation portion of the study were compiled, they were compared to expected valence and arousal ratings pulled from ANEW (Bradley & Lang, 1999) both numerically and categorically. Of the total 120 words used in the study, 20 of them were rated to be in a different valence category from what was expected based on ANEW. Of these, two were emotion label, five were emotion laden, and 13 were neutral words. Of the miscategorized words, three were negative, four were positive, and 13 were neutral valence (see Table 1). In terms of how word valence categories differed in their ratings, all seven positive and negative words that were miscategorized were rated as neutral, whereas all 13 neutral words were rated as negative (see Figure 13). It is worth noting that participants were not asked to provide a categorical rating for these words, rather their numerical ratings for each word were used to re-categorize them based on commonly used valence cutoffs used in this and other studies (Kazanas & Altarriba, 2015b; Kuperman et al., 2014; Vinson et al., 2014)

Given that 20 out of the 120 words used were rated to be a different valence category than expected based on ANEW values, all previous analyses were re-run after recoding the trial characteristics based on the participant provided valence ratings rather than the ones taken from ANEW. This did not result in significant changes to the results. Additionally, the above analyses were re-run after removing completely any trial which included one or more of the mis-categorized words across any target word or either pair word. Because the presence of a miscategorized word anywhere in the target or pair words resulted in the deletion of the entire trial, this deletion reduced the number of trials by about 40%, and disproportionately impacted neutral blocks because more than half of the neutral words were miscategorized. As a result, these analyses will be disregarded for the purposes of the present paper. While miscategorization of the neutral words impacted nearly half of experimental trials, the recoding of those miscategorized stimuli had minimal impact on the results of the main analyses.

Discussion

The present study sought to characterize the ways in which emotion word type and valence may influence processing through the use of a semantic satiation paradigm and a novel valence matching task. More specifically, the question of what kinds of semantic characteristics can be manipulated via semantic satiation, and by extension whether or not valence can be satiated, was of primary interest.

Hypothesis 1: Priming & Satiation Effects

Expected satiation effects were observed via planned contrasts across several analyses, though these results were qualified by interactions with other variables. Namely, priming and satiation effects were seen primarily on positive emotion-laden words when other variables were taken into account. This means that H1, which hypothesized that primed stimuli would elicit faster reaction times than satiated stimuli, was only supported under limited circumstances in the present study. This finding implies that neither valence nor word type alone are sufficient to predict whether satiation effects will be seen for a given word stimulus. Previous literature suggests that satiating a word should result in longer RTs when responding to some aspect of that word's semantics (Lindquist et al., 2006; Tian & Huber, 2010), but these findings were not consistently replicated in the present study. This is particularly interesting in that satiation was in fact not observed on a large portion of stimuli, including negative, emotion-label, and neutral stimuli.

The lack of observed satiation effects for negative words may be partially supported in the literature, potentially reflecting the manner in which negative stimuli capture attention. Negative stimuli tend to draw attention more quickly and are harder to disengage from, due to increased emotional salience (Estes & Aldeman, 2008; Koster et al., 2005; Kousta et al., 2009; Sutton & Lutz, 2018; Vinson et al., 2014; Yiend, 2010). This emotional salience may be much harder to satiate, resulting in the lack of observed satiation in the present study. Previous satiation literature with negatively-valenced stimuli has found effects based on emotion congruence with images of faces (Gendron et al., 2012; Lindquist et al., 2006), though these studies did not look at the satiation of negative or positive valence itself, but rather the satiation of a particular emotion (e.g., "sad" or "joy"). There have not been other studies which examined negative and positive stimuli as a core focus, nor studies which investigate whether a negative or positive valence itself can be satiated.

The observed lack of differences between primed and satiated trials may also be compounded by semantic priming acting on the emotional characteristics of the negative words. Negative stimuli are known to capture attention automatically and hold attention for longer as a result of their emotional salience (Estes & Aldeman, 2008; Koster et al., 2005; Sutton & Lutz, 2018). Semantic priming makes the semantic elements of a primed word more accessible, often resulting in faster reaction times. It may be the case that priming a negative word also primes its heightened emotional salience, in a sense amplifying attentional capture effects and making the stimulus even harder to disengage from. Few studies have analyzed the effects of priming on negative words in particular, but Gohier et al. (2013) found that negative words exhibited significantly reduced priming effects for female participants. This supports the current finding that, at least under certain conditions, negative words may behave differently in a paradigm utilizing semantic priming when compared to positive or neutral stimuli. As a result, reduced satiation effects for negative words combined with expected slower processing of negative words may have combined to obscure expected priming and satiation differences.

Hypothesis 2: Valence Effects

It was hypothesized in H2 that negative words would exhibit slower reaction times than positive words across satiation and word type conditions. These effects were, by and large, not supported in the present findings, with the exception of the differences found between primed, negative, emotion-laden words and positive, emotion-laden, satiated words. Previous literature suggests that because semantic information is what is being manipulated via the satiation paradigm, it may be possible to satiate positive or negative valence in addition to just a specific emotion like sadness or anger (L. Smith & Klein, 1990; Tian & Huber, 2010). The only semantic characteristic varying systematically in the present study was valence, and no studies have indicated that word type can be satiated in and of itself. The relative lack of significant findings may indicate that, while semantic information is an important mechanism by which semantic satiation operates, valence itself may not be sufficient to elicit semantic satiation effects in the present paradigm.

One interesting finding in the study was the relatively large proportion of neutral words which differed in their valence (and as a result, word-type) based on participant valence ratings versus ANEW valence ratings. Of the 40 neutral words used in the study, 13 of them were categorized as negatively valenced by participants, potentially indicating that the ANEW ratings aren't robust in all individuals, or with samples below a certain size. While ratings in the present study were collected after all experimental trials had been completed, the word ratings from all participants were considered in calculating the averages. Participants in both the positive and negative trial conditions consistently tended to rate neutral words as negative. This means it is unlikely that the differences observed were due to the influence of the trials presented to participants. While it is not entirely clear exactly why neutral words were rated as negative, recoding the trials based on participant-provided valence ratings did not significantly change the results of the main analyses. This may suggest that while participants have a particular response to a given word in the context of a brief exposure during an experimental trial, explicitly asking them to rate the same word in the absence of any time window or external task may elicit a different response. That being said, the analyses and findings in the present study were robust to the differences in valence ratings observed.

Hypotheses 3 & 4: Word Type Effects

Neutral words had slower RTs overall than emotion-label and emotion-laden words, with no significant differences between emotion-label and emotion-laden words. This supports H4 laid out in the present study, though predicted word type differences between emotion-label and emotion-laden words as stated in H3 were not found. Based on these findings, only a portion of the hypotheses laid out for the present study were supported, namely that neutral words exhibited smaller satiation and priming effects compared to emotion-label and emotion-laden words. It was originally predicted that emotion-label words would exhibit the largest processing differences based on valence and satiation condition, with emotion-laden words showing smaller effects and neutral words showing even smaller, or no effects.

These predictions were based on previous studies which focused on processing differences between emotion-label and emotion-laden words. The studies which found word type differences used a variety of tasks and experimental paradigms, including masked and unmasked LDT (Havas et al., 2007; Kazanas, 2013), affective priming paradigms (Kazanas & Altarriba, 2015b), rapid serial visual processing paradigms (Knickerbocker & Altarriba, 2013), affective Simon tasks (Altarriba & Basnight-Brown, 2011), as well as a range of tasks alongside ERP data collection (Wu et al., 2019; Zhang et al., 2017, 2018; Zhang, Teo, et al., 2019; Zhang, Wu, et al., 2019). All of these studies looked specifically at the word type distinction and used more well established tasks to evaluate processing differences as compared to the task used in the present study. That being said, there are a number of studies which do not find differences between emotion-label and emotion-laden words. Studies examining ERP (Zhang et al., 2017) and hemispheric processing (Martin & Altarriba, 2017) have failed to find robust differences between emotion-laden and emotion-label words, or have only found differences when considering specific factors, such as valence or task characteristics. This suggests that the emotion word type distinction may only be relevant to certain processing tasks, and not influential in every paradigm. Additionally, the semantic satiation paradigm has been used with emotion-specific satiation effects, such as satiating “sad” to impact reaction times to a subsequently presented sad face (Lindquist et al., 2006), but not with word type as a main variable of interest. This may speak to the propriety of using semantic satiation to assess word-type differences.

Neutral words did exhibit smaller effects than either emotion word type, as predicted, but emotion-laden words resembled emotion-label words much more than they did neutral words. The difference between overall reaction times between neutral words and the other emotion word types was larger than expected, and this may be due to several factors. The slower processing of neutral words has been previously demonstrated by studies looking at the manner in which valence affects word processing (Kousta et al., 2009; Vinson et al., 2014; Yiend, 2010), and these studies emphasize the reduced attention captured by neutral stimuli as compared to valenced stimuli. Neutral words may also be harder to categorize as belonging to a particular valence within a short response window, since they may not immediately be recognized as belonging to either a positive or negative valence category. Finally, neutral words differed much more frequently in their participant-provided ratings versus their ANEW ratings. This seems to indicate much more ambiguity in evaluating the valence of neutral words, potentially leading to longer reaction times and less accurate categorization. Ratings of neutral words could be impacted by the repeated presentation of valenced words prior to rating, such that participants shown repeated negative words may rate neutral words more negatively, for example. The myriad of factors potentially influencing the perception and processing of neutral words make it difficult to attribute any one as the main factor driving observed differences in the present study.

Mood State Effects

Analyses based on mood state mood state were included in the present study after determining that a significant portion of the sample scored above clinical threshold on one or more of the inventories used. The inclusion of mood state did not significantly alter the results of the main repeated measures analyses, though it was also included in exploratory regression analyses as a continuous variable. It was possible to include the mood state measures in the present study in a number of different ways for the purposes of analysis. In the above repeated measures analyses, mood state was included as a binary factor, separating participants into groups based on whether they scored on the BDI. This coding approach was most supported in the literature, which emphasizes the influence of depressive symptomologies on processing of negative stimuli (e.g., Koster et al., 2005). Based on previous literature indicating that depression as measured by the BDI should be the main driving factor behind processing differences, the BDI binary coding method was considered the most sound approach for the main analyses.

One additional coding method for mood state is based on whether a given participant scored on one or more of the mood state inventories used. This method would minimize the impact on group size at the cost of confounding differences due to depression as measured by the BDI and anxiety as measured by the STAI, as well as effects from participants who scored on both inventories. Exploratory comparisons of the BDI binary and overall scoring binary recoding methods against the 4-level factor coding indicated that the two binary recoding methods were not different from one another in overall significance of main effects and interactions, and so only the BDI scoring binary was used for the main analyses.

Novel Task in the Present Study

The present study utilized a novel task in the satiation paradigm, here called the paired valence match task. This task involved evaluating the valence of two simultaneously presented words, and responding based on whether the valence of these words was the same or different, regardless of the primed or satiated target word’s valence. Other tasks, such as the LDT, have been shown to be insensitive to semantic satiation (Cohene et al., 1978; Neely, 1977; Smith, 1984), and simple category membership tasks often used in satiation literature (Kounios et al., 2000; Smith, 1984; Smith & Klein, 1990; Tian & Huber, 2010) did not allow for evaluation of word type or valence differences in the words used in the present study.

One of the central questions of the present study was whether a given valence can be satiated, and how the effects of this satiation may differ based on word type. Assessing this question required that the task be word based, require evaluation of at least the valence characteristics of the words used, and not rely on simple category membership. As a result, the paired valence match task was created and used for the present study. Analyses of accuracy data for each participant and each trial within the paradigm indicated that overall accuracy was much lower than commonly used tasks in satiation studies, which typically use an accuracy cutoff of 90% (Tian & Huber, 2010). In this task, our accuracy ranged from 57.63% to 83.33% (*M*=70.17%, SD=5.39%), with no participants below chance and no participants above 85% accuracy, despite a very high response rate for most participants (*M*=98.2%, SD=3.78%). The apparent difficulty of this task may have obscured some expected effects in the present study, and more studies may be necessary to validate the applicability of this task to satiation or other paradigms.

The observed differences in valence ratings between ANEW and participant responses may also be an artifact of the present task. Participant ratings provided after experimental trials indicated a large proportion of neutral words were perceived as negative. While participants responded in this way when explicitly asked to rate valence characteristics, the results of experimental analyses did not significantly change when the trials were re-coded according to participant ratings. This suggests that the ratings of valence may differ from how the words are processed and perceived in the midst of an experimental trial, or how they’re processed in the pair valence match task specifically. These differences merit further exploration in the context of the paired valence match task as well as in other tasks using valence and other word characteristics.

It is difficult to say whether the task, or the satiation paradigm, for that matter, is sensitive to emotion word type differences as examined in the present study. Finally, the task used introduced another set of details which may have impacted the lack of expected effects observed in the present study. On each trial, participants were required to evaluate whether the word pair on screen had matching or mismatching valences. This, combined with previous semantic manipulation via the semantic satiation paradigm may have made the task relatively difficult to complete accurately in the provided timeframe. Moreover, its entirely possible that the placement of pair words on screen impacted reaction times, allowing the semantic characteristics of one word to be the driving factor behind observed differences. Even though participants had to read both pair words, they likely always read the top word before the bottom word, and this could have introduced additional variance into the RT data.

These considerations, combined with lower accuracy ratings for the task used in the present study indicate the necessity of further testing of this task. Using this task with a wider range of paradigms would be useful to examine the kinds of factors that interact with the task characteristics, such as the semantic satiation manipulation did here. The kinds of information that must be evaluated for the successful completion of the task may also be worth exploring, such as using non-emotional category membership as a match/mismatch criterion, or adapting other tasks such as LDT into a pair match format.

Implications for PDP Models of Word Processing

The findings in the present study are also situated within a larger body of literature on the influences of valence on word processing. This research has largely emphasized the role of valence as a driving influence on processing more so than arousal, though arousal has been shown to be more relevant to certain processes. The present study controlled for the arousal of words used for stimuli, and therefore arousal will not be discussed. In terms of valence, the present study's findings suggest that while valence does have an impact on word processing in some cases, there are other factors, especially given the task used and other experimental design features, which may overshadow valence's effects. Valence's effects varied based on word type and semantic manipulation, indicating that non-valence related characteristics were at least as influential as valence. These findings point to factors besides valence as driving observed processing differences.

Valence was used as a characteristic of interest for this reason, as previous studies have not considered whether valence itself can be satiated, nor whether that satiation can be carried over different word types and emotions within a larger valence category. Effects from priming and satiation manipulations used in this paradigm were seen on a subset of trials trials, but as widely as may have been expected. This raises the question of why not all stimuli exhibited the expected effects, or what other factors may have been at play to mask those effects. As previously discussed, the salience and attention capturing nature of negative stimuli may make them less susceptible to satiation via valence as opposed to a more specific negative emotion. The relative complexity of negative emotions compared to positive emotions may also be a factor in this case.

Positive emotions are much more limited in the range of characteristics they represent, with "happy" being a central emotion and many other positive emotions being variations on "happy" with slightly different nuances (e.g., "contentment", "joy"). Negative emotions on the other hand constitute a much broader category, ranging from high arousal "angry" and "rage" to lower arousal "sad" and "dejected" (Russell, 1980). This difference in category size may be a factor contributing to the observed lack of satiation in a range of stimuli, as it is possible that satiating negative valence is not specific enough to act on the wide range of possible associations within that valence concept via PDP model activation. Within a PDP model of word processing, the repeated activation of negative emotional characteristics may not be sufficient to exhaust those connections as would be expected in semantic satiation, and may instead keep them more accessible as would be expected in repetition priming. This finding alone necessitates further study, as there is virtually no literature looking specifically at valence categories and semantic satiation in words.

One of the goals of the present study was to contribute to word processing models, and inform what kinds of emotional characteristics are necessary to consider when looking at word processing. Current models often leave out significant considerations to emotional content, and the present study shows that any number of emotional characteristics are important to consider in word processing, and makes a case for the necessity of considering these characteristics simultaneously. As far as PDP models are concerned, the present study found some effects which were well explained by existing understanding of semantic activation in a PDP model, including semantic satiation effects and the influence of a range of characteristics on the retrieval of a given word from the lexicon.

Conclusion

To summarize, the present study found inconsistent support for expected priming and satiation differences (H1), no consistent differences in RTs based on word valence (H2), emotion-label and emotion-laden words did not differ significantly in observed processing differences (H3) and that neutral words elicited slower RTs than either emotion-label or emotion-laden words (H4). Some of the central questions the present study sought to answer focused on just what aspects of a word’s semantic information can be manipulated, and how better understanding these characteristics may contribute to word processing models. The theoretical background of these questions is based in PDP models of word processing. These models propose that all semantic characteristics of a word are stored separately in the lexical system, and accessing a particular word in the lexical system is actually a result of activating all or most of the individual features of that word (Lupker, 2008). This approach to word processing frames nicely many of the present findings, and helps to better synthesize them into more practical insights about how we process emotional content in words.

The fact that emotional stimuli are extremely commonplace in our everyday lives necessitates discussion of how the present findings may be incorporated into other areas of study as well as applications beyond research. Perhaps most immediately relevant to the present study is the use of emotional language in inventories used to assess for mood disorders, as well as in other psychological assessment tools. The use of more direct, emotion-label word heavy language may impact responses on such tools, and in the same vein use of emotion-laden words as a way to avoid emotion-label words may not be entirely free of influence on responses. Its important to consider the ways in which we construct language-based assessments of emotional state and other measures. One of the main findings of the present study related mood state of the participants to emotion word processing, and these findings are very much applicable to any number of psychiatric and psychological fields, as well as more broadly to fields dealing with natural language processing. Considering the use of emotional language as a communicative tool, it may be possible to integrate findings in the present study into artificial intelligence applications. A computer which is able to better understand what emotional information is important for communication will be better able to understand and communicate with human beings at large.

References

Adolphs, R. (2001). The neurobiology of social cognition. *Current Opinion in Neurobiology*, *11*(2), 231–239.

Ahern, G. L., & Schwartz, G. E. (1979). Differential lateralization for positive versus negative emotion. *Neuropsychologia*, *17*(6), 693–698.

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*(3), 310–328. https://doi.org/10.1177/1367006910379261

Altarriba, J., & Basnight-Brown, D. M. (2012). The acquisition of concrete, abstract, and emotion words in a second language. *International Journal of Bilingualism*, *16*(4), 446–452. https://doi.org/10.1177/1367006911429511

Altarriba, J., & Bauer, L. M. (2004). The distinctiveness of emotion concepts: A comparison between emotion, abstract, and concrete words. *American Journal of Psychology*, *117*(3), 389–410. https://doi.org/10.2307/4149007

Altarriba, J., Bauer, L. M., & Benvenuto, C. (1999). Concreteness, context availability, and imageability ratings and word associations for abstract, concrete, and emotion words. *Behavior Research Methods, Instruments, & Computers*, *31*(4), 578–602. https://link.springer.com/content/pdf/10.3758/BF03200738.pdf

Balota, D. A., & Black, S. R. (1997). Semantic satiation in healthy young and older adults. *Memory & Cognition*, *25*(2), 190–202. https://doi.org/10.3758/BF03201112

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*(3), 445–459. https://link.springer.com/content/pdf/10.3758/BF03193014.pdf

Beck, A. T., Steer, R. A., & Brown, G. K. (1996). *BDI-II, Beck depression inventory: Manual*. Psychological Corp. https://vufind.carli.illinois.edu/vf-uic/Record/uic_1515646/Cite

Becker, M. W. (2012). Negative emotional photographs are identified more slowly than positive photographs. *Attention, Perception, & Psychophysics*, *74*, 1241–1251. https://doi.org/10.3758/s13414-012-0308-x

Borod, J. C., Obler, L. K., Erhan, H. M., Grunwald, I. S., Cicero, B. A., Welkowitz, J., Agosti, R. M., & Santschi, C. (1998). Right hemisphere emotional perception: Evidence across multiple channels. *Neuropsychology*, *12*(3), 446–458. https://doi.org/10.1037/0894-4105.12.3.446

Bradley, M. M., & Lang, P. J. (1994). Measuring emotion: The self-assessment manikin and the semantic differential. *Journal of Behavior Therapy and Experimental Psychiatry*, *25*(1), 49–59. https://doi.org/10.1016/0005-7916(94)90063-9

Bradley, M. M., & Lang, P. J. (1999). Affective norms for English words (ANEW): Instruction manual and affective ratings. In *Technical Report C-1*. https://doi.org/10.1109/MIC.2008.114

Cedrus Corporation. (2007). *SuperLab* ((Version 4.0)). Cedrus Corporation.

Citron, F. M. M. (2012). Neural correlates of written emotion word processing: A review of recent electrophysiological and hemodynamic neuroimaging studies. *Brain and Language*, *122*(3), 211–226. https://doi.org/10.1016/j.bandl.2011.12.007

Cohene, L., Smith, M., & Klein, D. (1978). Semantic satiation revisited with a lexical decision task. *Memory & Cognition*, *6*(2), 131–140. https://doi.org/10.3758/BF03197438

Estes, Z., & Aldeman, S. J. (2008). Automatic vigilance for negative words is categorical and general. *Emotion*, *8*(4), 453–457. https://doi.org/10.1037/a0012887

Feldman Barrett, L., & Russell, J. A. (1998). *Independence and bipolarity in the structure of current affect*. *74*(4), 967–984. https://www.affective-science.org/pubs/1998/FBRussell1998.pdf

Field, A. (2017). *Discovering statistics using IBM SPSS statistics* (5th ed.). SAGE Publications Ltd.

Herba, C. M., Landau, S., Russell, T., Ecker, C., & Phillips, M. L. (2006). The development of emotion-processing in children: Effects of age, emotion, and intensity. *Journal of Child Psychology and Psychiatry*, *47*(11), 1098–1106. https://doi.org/10.1111/j.1469-7610.2006.01652.x

Holtgraves, T., & Felton, A. (2011). Hemispheric asymmetry in the processing of negative and positive words: A divided field study. *Cognition & Emotion*, *25*(4), 691–699. https://doi.org/10.1080/02699931.2010.493758

Hugdahl, K. (1995). Classical conditioning and implicit learning: The right hemisphere hypothesis. In R. J. Davidson & K. Hugdahl (Eds.), *Brain Asymetry* (pp. 235–266). The MIT PRess.

Inaba, M., Kamishima, K., & Ohira, H. (2007). An electrophysiological comparison of recollection for emotional words using an exclusion recognition paradigm. *Brain Research*, *1133*, 100–109. https://doi.org/10.1016/J.BRAINRES.2006.07.010

Jakobovits, L. A., & Hogenraad, R. (1967). Some suggestive evidence on the operation of semantic generation and satiation in group discussions. *Psychological Reports*, *20*, 1247–1250. http://journals.sagepub.com/doi/pdf/10.2466/pr0.1967.20.3c.1247

Jakobovits, L. A., & Lambert, W. E. (1962). Semantic satiation in an addition task. *Canadian Journal of Psychology/Revue Canadienne de Psychologie*, *16*(2), 112–119. https://doi.org/10.1037/h0083238

JASP Team. (2019). *JASP* (0.11.1). https://jasp-stats.org/

Kahan, T. A., & Hely, C. D. (2008). The role of valence and frequency in the emotional Stroop task. *Psychonomic Bulletin and Review*, *15*(5), 956–960. https://doi.org/10.3758/PBR.15.5.956

Kanske, P., & Kotz, S. A. (2007). Concreteness in emotional words: ERP evidence from a hemifield study. *Brain Research*, *1148*(1), 138–148. https://doi.org/10.1016/j.brainres.2007.02.044

Kazanas, S. A., & Altarriba, J. (2015a). Emotion word processing: Effects of word type and valence in Spanish–English bilinguals. *Journal of Psycholinguistic Research*, *45*(2), 395–406. https://doi.org/10.1007/s10936-015-9357-3

Kazanas, S. A., & Altarriba, J. (2015b). The automatic activation of emotion and emotion-laden words: Evidence from a masked and unmasked priming paradigm. *The American Journal of Psychology*, *128*(3), 323. https://doi.org/10.5406/amerjpsyc.128.3.0323

Killgore, W. D. S., & Yurgelun-Todd, D. A. (2007). The right-hemisphere and valence hypotheses: Could they both be right (and sometimes left)? *Social Cognition and Affective Neurscience*, *2*(3), 240–250. https://doi.org/10.1093/scan/nsm020

Knickerbocker, H., & Altarriba, J. (2013). Differential repetition blindness with emotion and emotion-laden word types. *Visual Cognition*, *21*(5), 599–627. https://doi.org/10.1080/13506285.2013.815297

Kounios, J., Kotz, S. A., & Holcomb, P. J. (2000). On the locus of the semantic satiation effect: Evidence from event-related brain potentials. *Memory & Cognition*, *28*(8), 1366–1377. https://doi.org/10.3758/BF03211837

Kousta, S.-T., Vigliocco, G., Vinson, D. P., Andrews, M., & Del Campo, E. (2011). The representation of abstract words: Why emotion matters. *Journal of Experimental Psychology: General*, *140*(1), 14–34. https://doi.org/10.1037/a0021446

Kousta, S.-T., Vinson, D. P., & Vigliocco, G. (2009). Emotion words, regardless of polarity, have a processing advantage over neutral words. *Cognition*, *112*(3), 473–481. https://doi.org/10.1016/j.cognition.2009.06.007

Kuchinke, L., Jacobs, A. M., Grubich, C., Võ, M. L.-H., Conrad, M., & Herrmann, M. (2005). Incidental effects of emotional valence in single word processing: An fMRI study. *NeuroImage*, *28*(4), 1022–1032. https://doi.org/10.1016/J.NEUROIMAGE.2005.06.050

Kuperman, V., Estes, Z., Brysbaert, M., & Warriner, A. B. (2014). Emotion and language: Valence and arousal affect word recognition. *Journal of Experimental Psychology, General*, *143*(3), 1065–1081. https://doi.org/10.1037/a0035669

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*(4), 455–452. https://doi.org/10.1037/1528-3542.8.4.445

Laszlo, S., & Plaut, D. C. (2012). A neurally plausible Parallel Distributed Processing model of Event-Related Potential word reading data. *Brain and Language*, *120*(3), 271–281. https://doi.org/10.1016/j.bandl.2011.09.001

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

Leppänen, J. M. (2006). Emotional information processing in mood disorders: A review of behavioral and neuroimaging findings. *Current Opinion in Psychiatry*, *19*(1), 34–39. https://doi.org/10.1097/01.yco.0000191500.46411.00

Lewis, M. B., & Ellis, H. D. (2000). Satiation in name and face recognition. *Memory & Cognition*, *28*(5), 783–788. https://doi.org/10.3758/BF03198413

Lindquist, K. A., Feldman Barrett, L., Bliss-Moreau, E., & Russell, J. A. (2006). Language and the perception of emotion. *Emotion*, *6*(1), 125–138. https://doi.org/10.1037/1528-3542.6.1.125

Lipp, O. V., & Derakshan, N. (2005). Attentional bias to pictures of fear-relevant animals in a dot probe task. *Emotion*, *5*(3), 365–369. https://doi.org/10.1037/1528-3542.5.3.365

Lupker, S. J. (2008). Visual word recognition: Theories and findings. *The Science of Reading: A*

Handbook, 39–60. https://doi.org/10.1002/9780470757642.ch3

Martin, J. M., & Altarriba, J. (2017). Effects of valence on hemispheric specialization for emotion word processing. *Language and Speech*, *60*(4), 597–613. https://doi.org/10.1177/0023830916686128

Maxwell, S. E. (1980). Pairwise Multiple Comparisons in Repeated Measures Designs. *Journal of Educational Statistics*, *5*(3), 269–287. https://doi.org/10.3102/10769986005003269

McClelland, J. L., & Rumelhart, D. E. (1987). *Parallel distributed processing (Vol. 2)*. MIT Press. http://web.stanford.edu/~jlmcc/papers/PDP/Volume 1/Chap1_Part1_PDP86.pdf

Paivio, A. (1986). *Mental representations : A dual coding approach*. Oxford University Press. https://books.google.com/books?id=hLGmKkh_4K8C&dq=a.paivio+word+representation+&lr=&source=gbs_navlinks_s

Pavlenko, A. (2008). Emotion and emotion-laden words in the bilingual lexicon. *Bilingualism*, *11*(2), 147–164. https://doi.org/10.1017/S1366728908003283

Pool, E., Brosch, T., Delplanque, S., & Sander, D. (2016). Attentional bias for positive emotional stimuli: A meta-analytic investigation. *Psychological Bulletin*, *142*(1), 79–106. https://doi.org/10.1037/bul0000026

Posner, J., Russell, J. A., & Peterson, B. S. (2005). The circumplex model of affect: An integrative approach to affective neuroscience, cognitive development, and psychopathology. *Development and Psychopathology*, *17*(3), 715–734. https://doi.org/10.1017/S0954579405050340

Posner, M. I., & Carr, T. H. (1992). Lexical access and the brain: Anatomical constraints on cognitive models of word recognition. *The American Journal of Psychology*, *105*(1), 1–26. https://doi.org/10.2307/1422979

Pratto, F., & John, O. P. (1991). Automatic vigilance: The attention-grabbing power of negative social information. *Journal of Personality and Social Psychology*, *61*(3), 380–391. https://doi.org/10.1037/0022-3514.61.3.380

Pynte, J. (1991). The locus of semantic satiation in category membership decision and acceptability judgment. *Journal of Psycholinguistic Research*, *20*(4), 315–335. https://doi.org/10.1007/BF01074284

RStudio Team. (2015). *RStudio: Integrated Development for R* (3.6.1). RStudio, Inc. http://www.rstudio.com/

Russell, J. A. (1980). A circumplex model of affect. *Journal of Personality and Social Psychology*, *39*(6), 1161–1178. https://doi.org/10.1037/h0077714

Russell, J. A., & Mehrabian, A. (1977). Evidence for a three-factor theory of emotions. *Journal of Research in Personality*, *11*, 273–294. https://doi.org/10.1016/0092-6566(77)90037-X

Smith, D., & Raygor, A. (1956). Verbal satiation and personality. *The Journal of Abnormal and Social Psychology*, *Vol 52*(3), 323–326. http://psycnet.apa.org/buy/1957-04368-001

Smith, L. (1984). Semantic satiation affects category membership decision time but not lexical priming. *Memory & Cognition*, *12*(5), 483–488. https://doi.org/10.3758/BF03198310

Smith, L., & Klein, R. (1990). Evidence for semantic satiation: Repeating a category slows subsequent semantic processing. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *16*(5), 852–861. https://doi.org/10.1037/0278-7393.16.5.852

Spielberger, C. D., Gorsuch, R., & Lushene, R. E. (1970). *Manual for the State-Trait Anxiety Inventory*. Consulting Psychologists Press. https://www.statisticssolutions.com/state-trait-anxiety-inventory-stai/

Stalans, L., & Wedding, D. (1985). Superiority of the left hemisphere in the recognition of emotional faces. *International Journal of Neuroscience*, *25*(3–4), 219–223. https://doi.org/10.3109/00207458508985373

Sutton, T. M., & Lutz, C. (2018). Attentional capture for emotional words and images : The importance of valence and arousal. *Canadian Journal of Experimental Psychology/Revue Canadienne de Psychologie Expérimentale*. https://doi.org/http://dx.doi.org/10.1037/cep0000154

The jamovi Project. (2019). *jamovi* (0.9). https://www.jamovi.org

Tian, X., & Huber, D. E. (2010). Testing an associative account of semantic satiation. *Cognitive Psychology*, *60*(4), 267–290. https://doi.org/10.1016/J.COGPSYCH.2010.01.003

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. https://doi.org/10.1016/j.brainres.2007.02.035

Vinson, D. P., Ponari, M., & Vigliocco, G. (2014). How does emotional content affect lexical processing? *Cognition and Emotion*, *28*(4), 737–746. https://doi.org/10.1080/02699931.2013.851068

Vogt, J., De Houwer, J., Koster, E. H. W., Van Damme, S., & Crombez, G. (2008). Allocation of spatial attention to emotional stimuli depends upon arousal and not valence. *Emotion*, *8*(6), 880–885. https://doi.org/10.1037/a0013981

Widen, S. C., & Russell, J. A. (2008). Children acquire emotion categories gradually. *Cognitive Development*, *23*(2), 291–312. https://doi.org/10.1016/J.COGDEV.2008.01.002

Wu, C., Zhang, J., & Yuan, Z. (2019). An ERP investigation on the second language and emotion perception: the role of emotion word type. *International Journal of Bilingual Education and Bilingualism*. https://doi.org/10.1080/13670050.2019.1703895

Yang, S., Luo, W., Zhu, X., Broster, L. S., Chen, T., Li, J., & Luo, Y. (2014). Emotional content modulates response inhibition and perceptual processing. *Psychophysiology, 51*, 1139–1146. https://doi.org/10.1111/psyp.12255

Yiend, J. (2010). The effects of emotion on attention: A review of attentional processing of emotional information. In J. De Houwer & D. Hermans (Eds.), *Cognition & Emotion: Reviews of Current Research and Theories* (pp. 211–275). Psychology Press. https://www.uv.mx/rmipe/files/2017/12/cognition_and_emotion.pdf#page=222

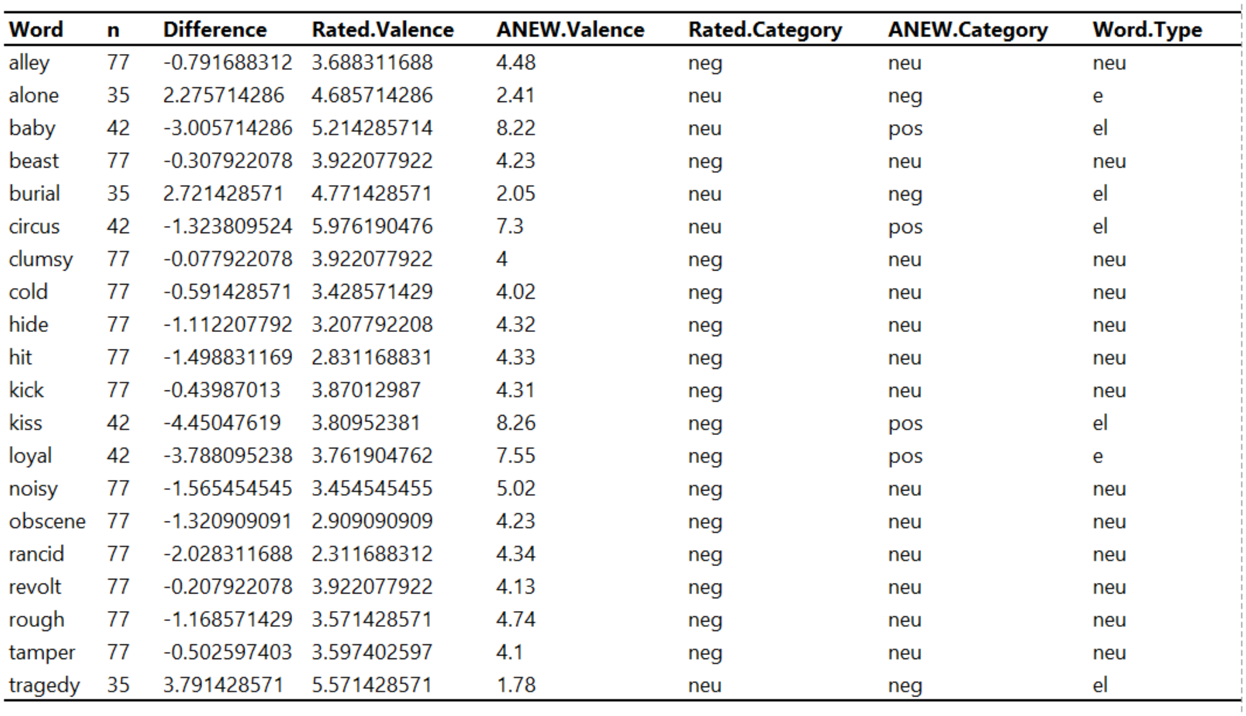
Zhang, J., Teo, T., & Wu, C. (2019). Emotion Words Modulate Early Conflict Processing in a Flanker Task: Differentiating Emotion-Label Words and Emotion-Laden Words in Second Language. *Language and Speech*, *62*(4), 641–651. https://doi.org/10.1177/0023830918807509

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). https://doi.org/10.3389/fnhum.2017.00455

Zhang, J., Wu, C., Yuan, Z., & Meng, Y. (2018). Different early and late processing of emotion-label words and emotion-laden words in second language: An ERP study. *Second Language Research*, 026765831880485. https://doi.org/10.1177/0267658318804850

Zhang, J., Wu, C., Yuan, Z., & Meng, Y. (2019). Differentiating emotion-label words and emotion-laden words in emotion conflict: an ERP study. *Experimental Brain Research*, *237*(9), 2423–2430. https://doi.org/10.1007/s00221-019-05600-4

Table 1. Word characteristics where participant ratings differed from ANEW ratings categorically



Word	n	Difference	Rated.Valence	ANEW.Valence	Rated.Category	ANEW.Category	Word.Type
alley	77	-0.791688312	3.688311688	4.48	neg	neu	neu
alone	35	2.275714286	4.685714286	2.41	neu	neg	e
baby	42	-3.005714286	5.214285714	8.22	neu	pos	el
beast	77	-0.307922078	3.922077922	4.23	neg	neu	neu
burial	35	2.721428571	4.771428571	2.05	neu	neg	el
circus	42	-1.323809524	5.976190476	7.3	neu	pos	el
clumsy	77	-0.077922078	3.922077922	4	neg	neu	neu
cold	77	-0.591428571	3.428571429	4.02	neg	neu	neu
hide	77	-1.112207792	3.207792208	4.32	neg	neu	neu
hit	77	-1.498831169	2.831168831	4.33	neg	neu	neu
kick	77	-0.43987013	3.87012987	4.31	neg	neu	neu
kiss	42	-4.45047619	3.80952381	8.26	neg	pos	el
loyal	42	-3.788095238	3.761904762	7.55	neg	pos	e
noisy	77	-1.565454545	3.454545455	5.02	neg	neu	neu
obscene	77	-1.320909091	2.909090909	4.23	neg	neu	neu
rancid	77	-2.028311688	2.311688312	4.34	neg	neu	neu
revolt	77	-0.207922078	3.922077922	4.13	neg	neu	neu
rough	77	-1.168571429	3.571428571	4.74	neg	neu	neu
tamper	77	-0.502597403	3.597402597	4.1	neg	neu	neu
tragedy	35	3.791428571	5.571428571	1.78	neu	neg	el

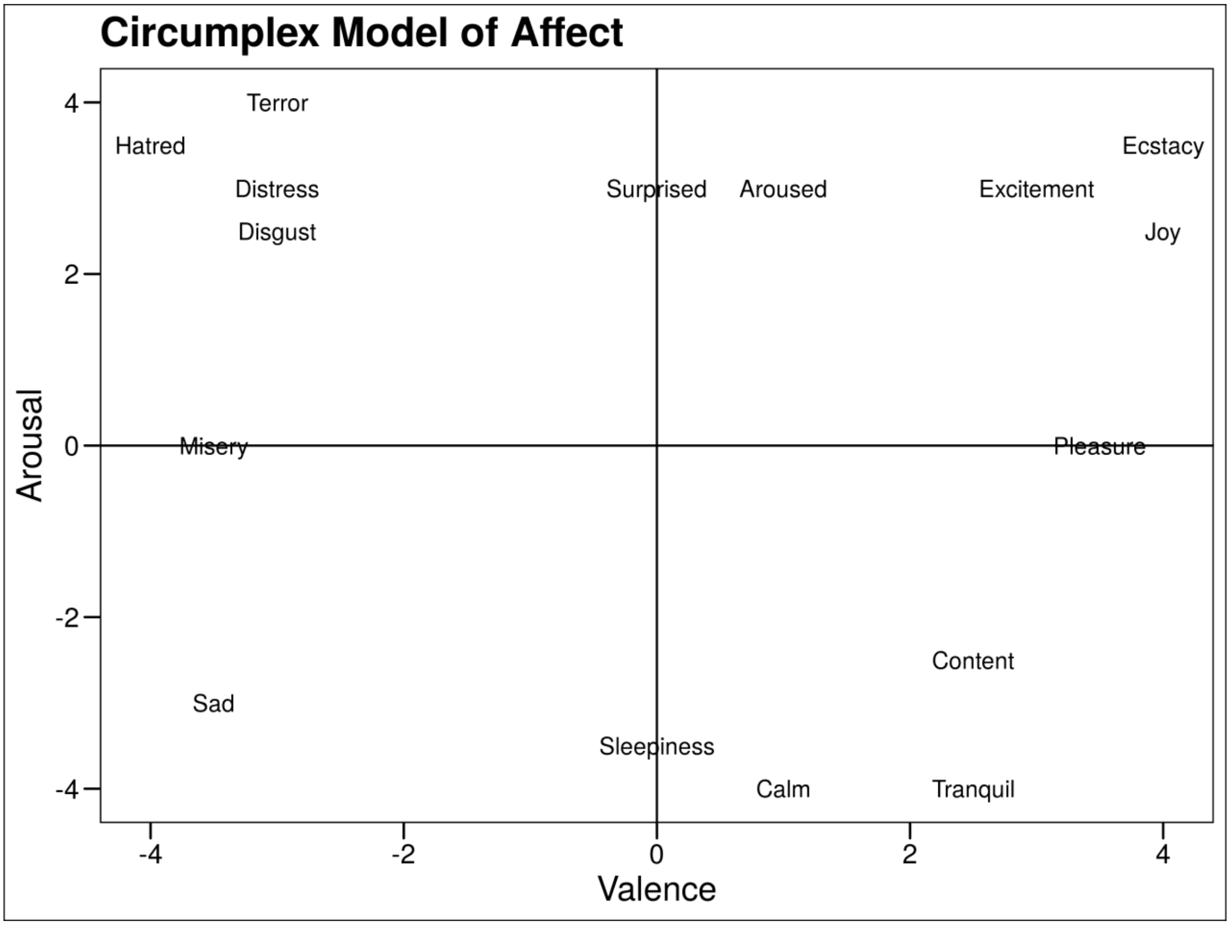


Figure 1. Position of emotion category labels according to valence (x axis) and arousal (y axis)

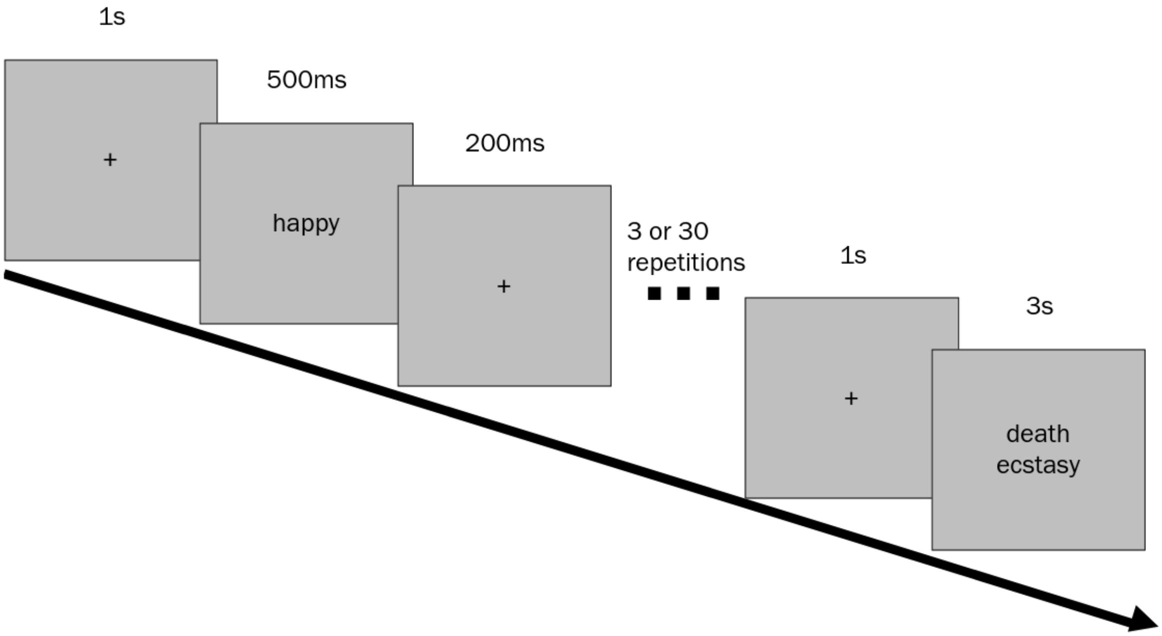


Figure 2. Example experimental trial

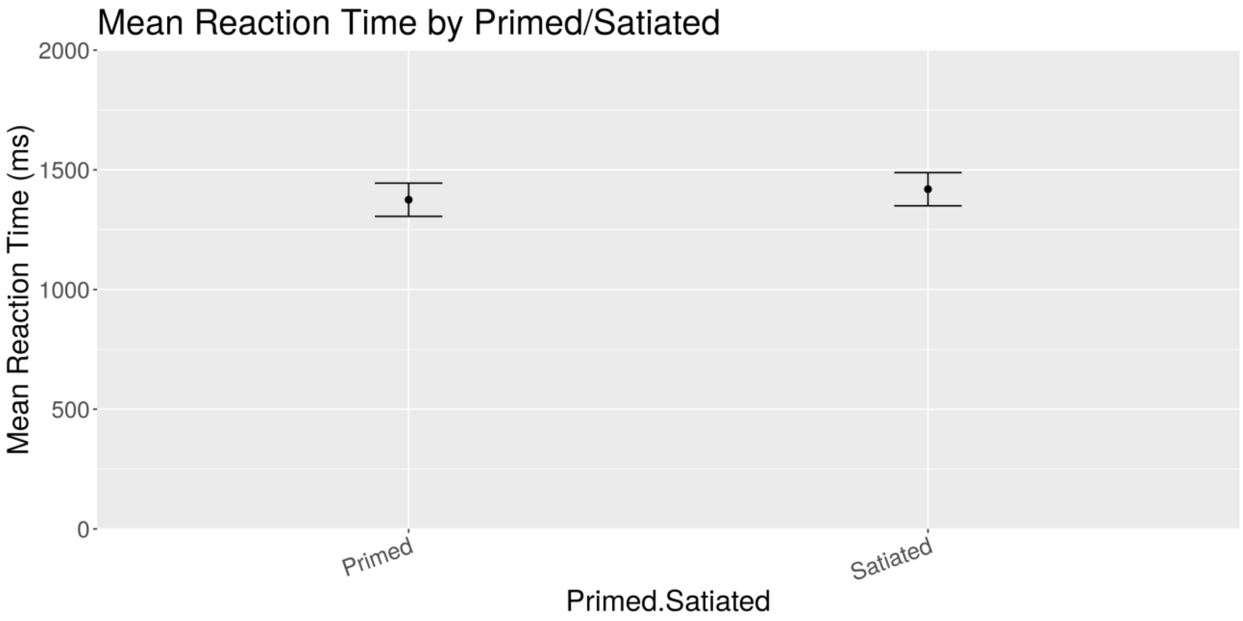


Figure 3. Main effect of priming/satiation, with error bars showing standard error (excluding neutral & mood state)

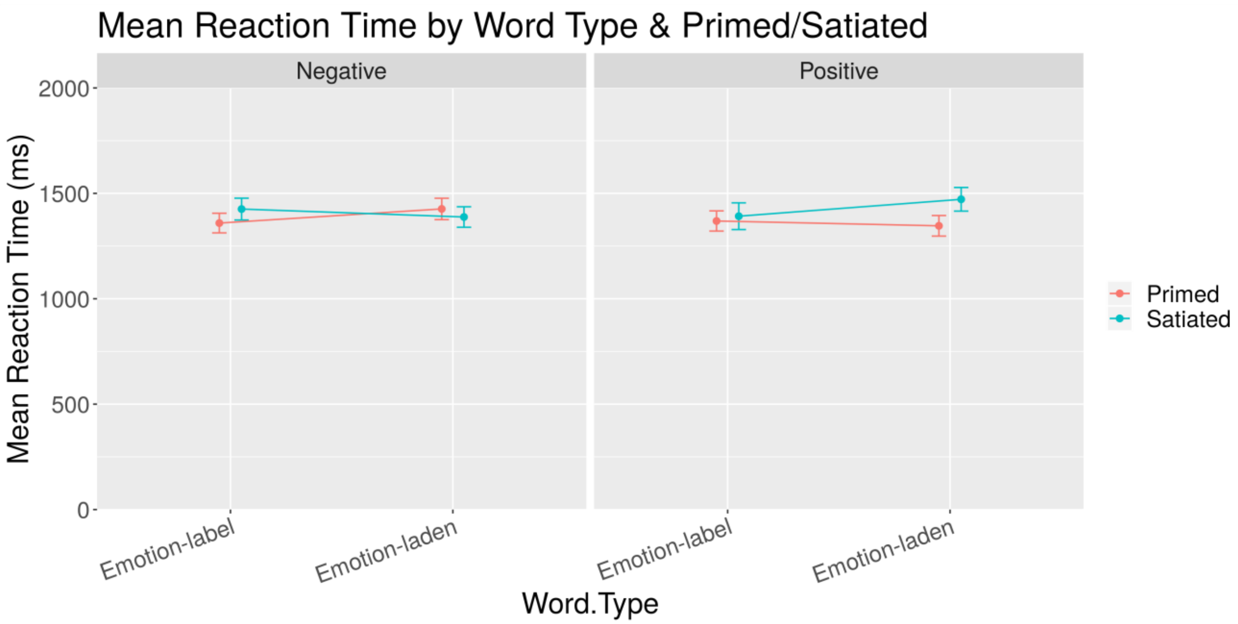


Figure 4. Interaction between word type, priming/satiation, and participant group, split by participant valence group, with error bars showing standard error (excluding neutral & mood state)

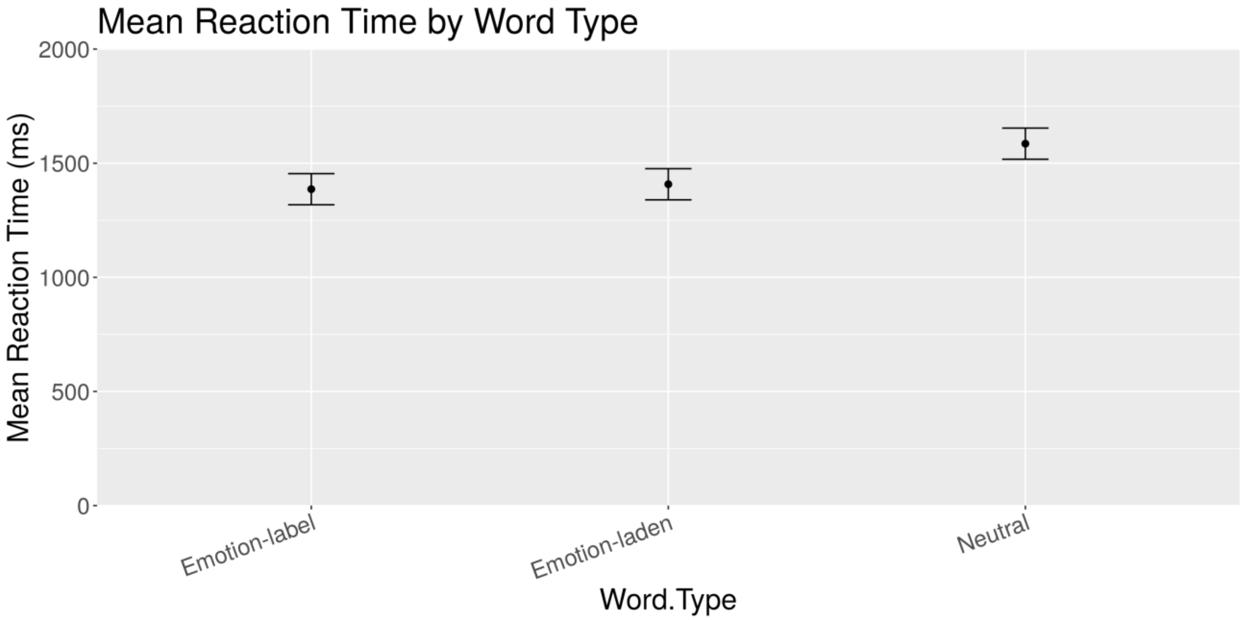


Figure 5. Main effect of word type, with error bars showing standard error (including neutral , excluding mood state)

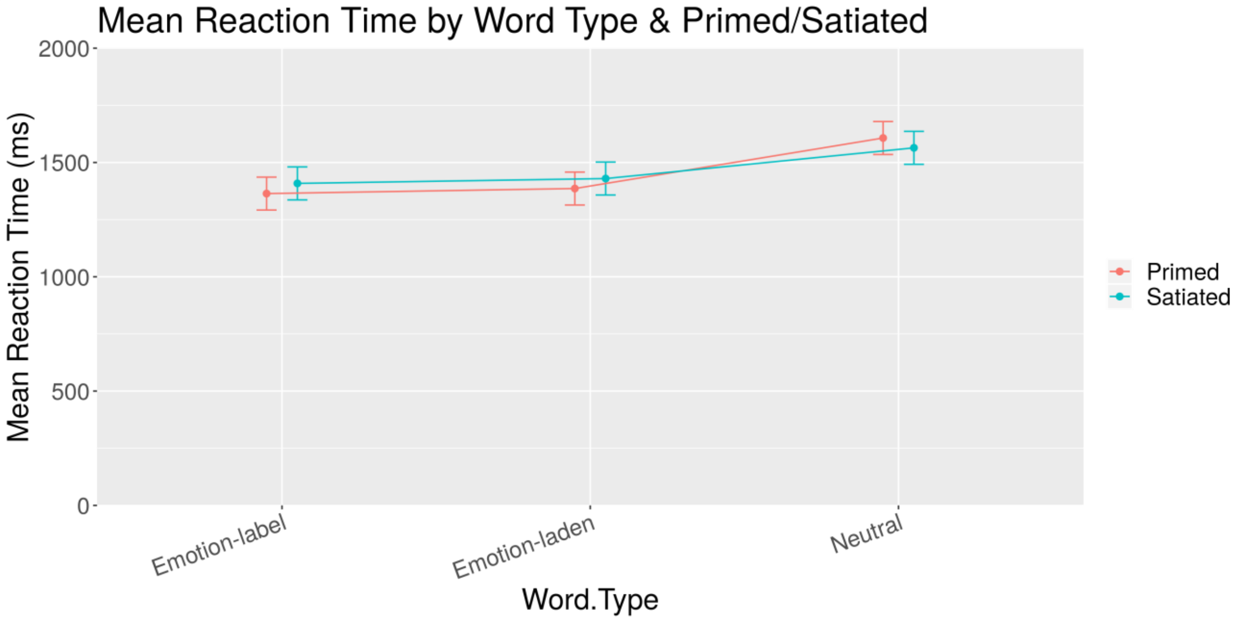


Figure 6. Interaction between word type and priming/satiation, with error bars showing standard error (including neutral , excluding mood state)

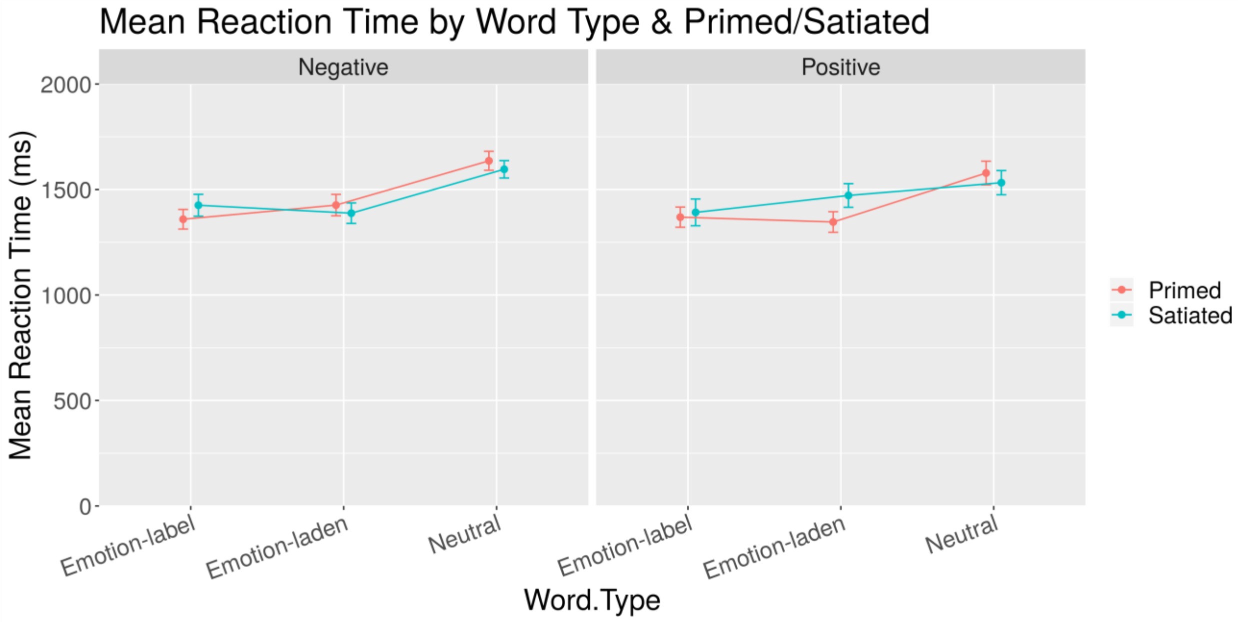


Figure 7. Interaction between word type, priming/satiation, and participant group, split by participant valence group, with error bars showing standard error (including neutral , excluding mood state)

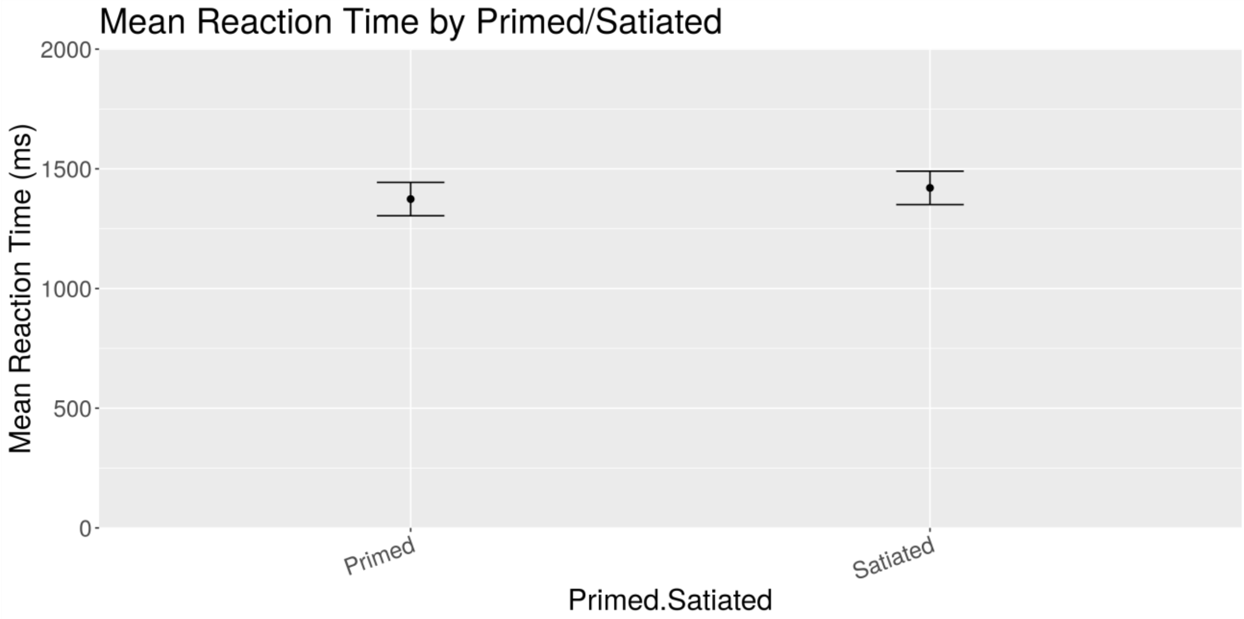


Figure 8. Main effect of priming/satiation, with error bars showing standard error (including BDI, excluding neutral)

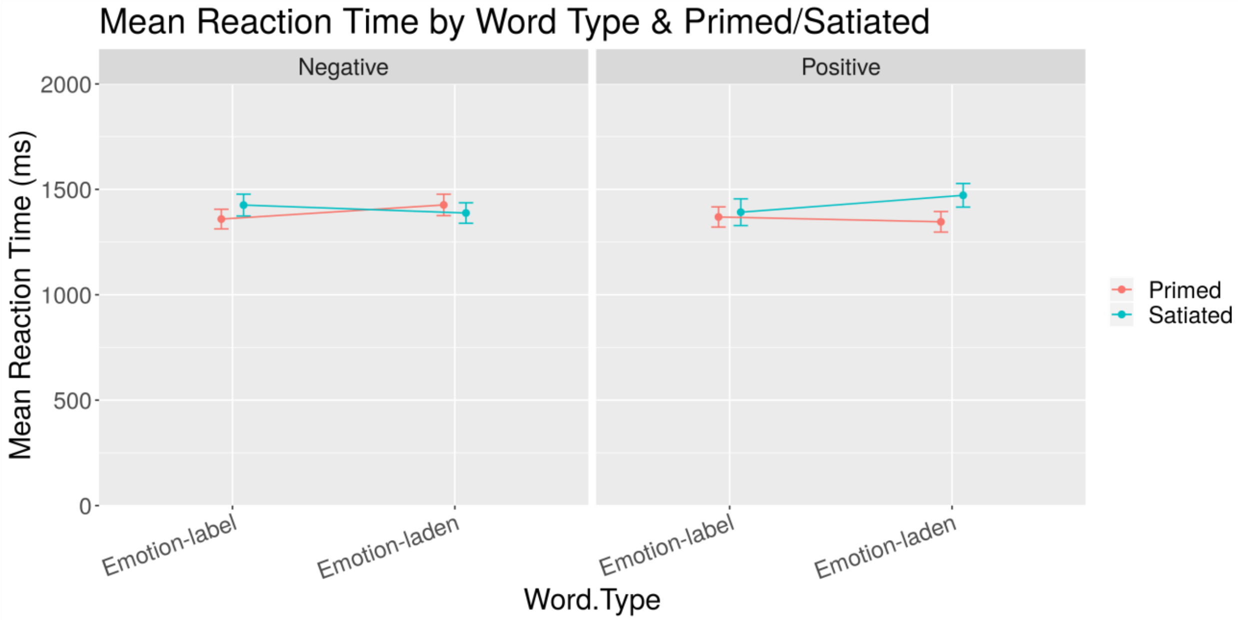


Figure 9. Interaction between word type, priming/satiation, and participant group, split by participant valence group, with error bars showing standard error (including BDI, excluding neutral)

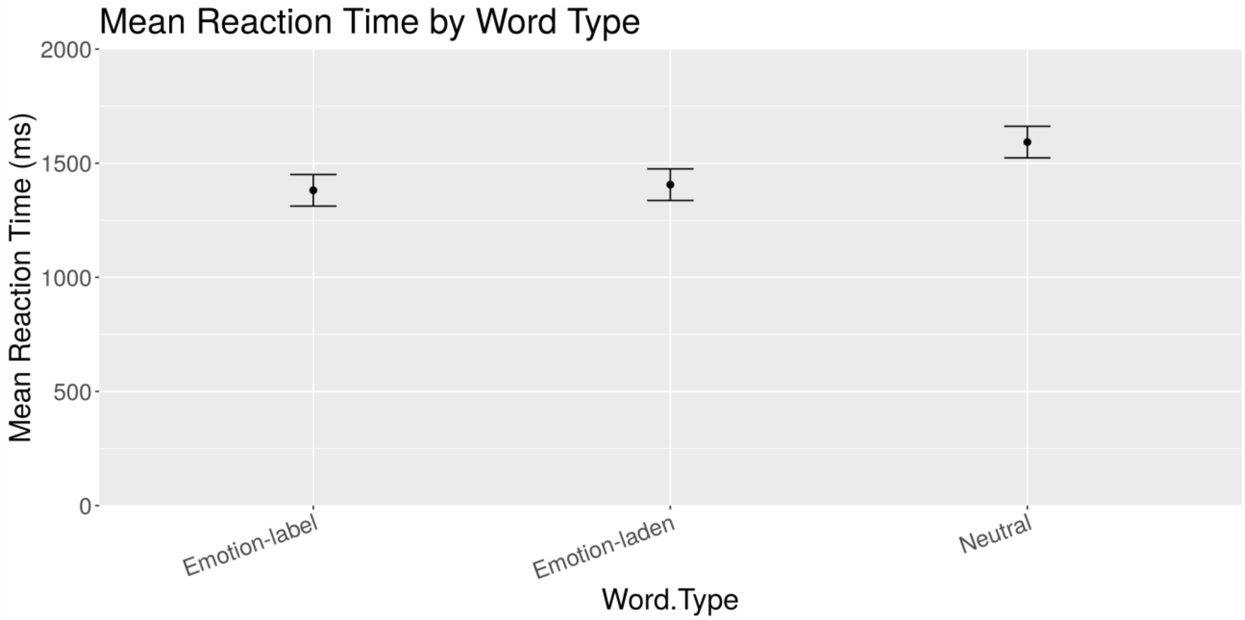


Figure 10. Main effect of word type, with error bars showing standard error (including BDI & neutral)

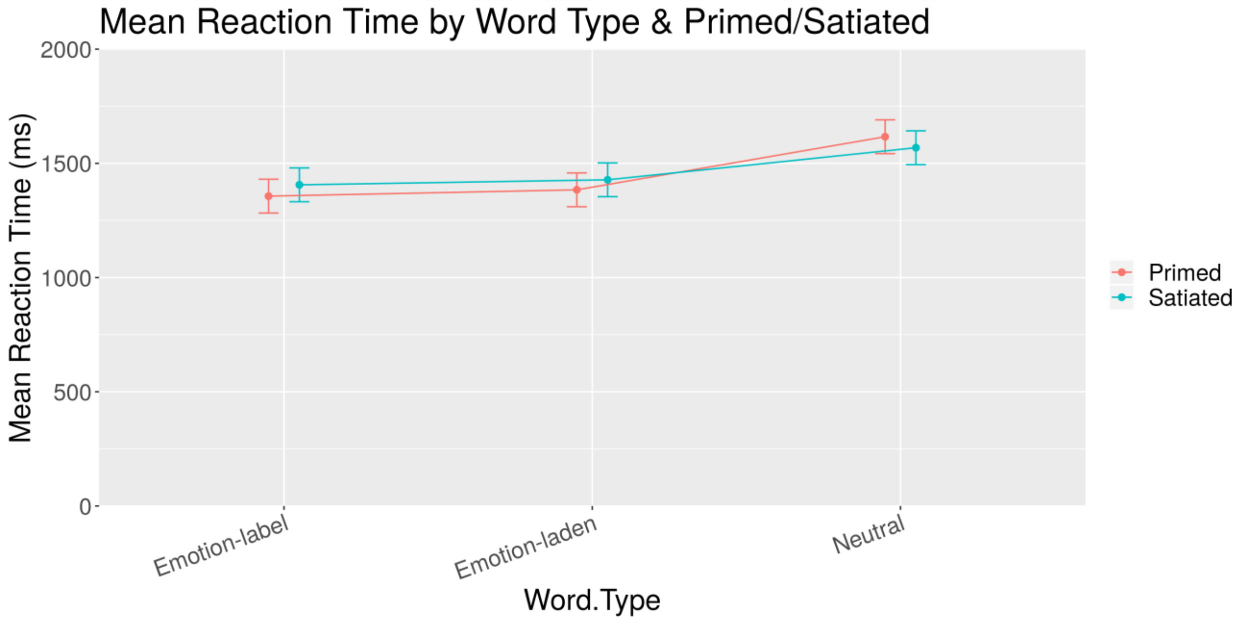


Figure 11. Interaction between word type and priming/satiation, with error bars showing standard error (including BDI & neutral)

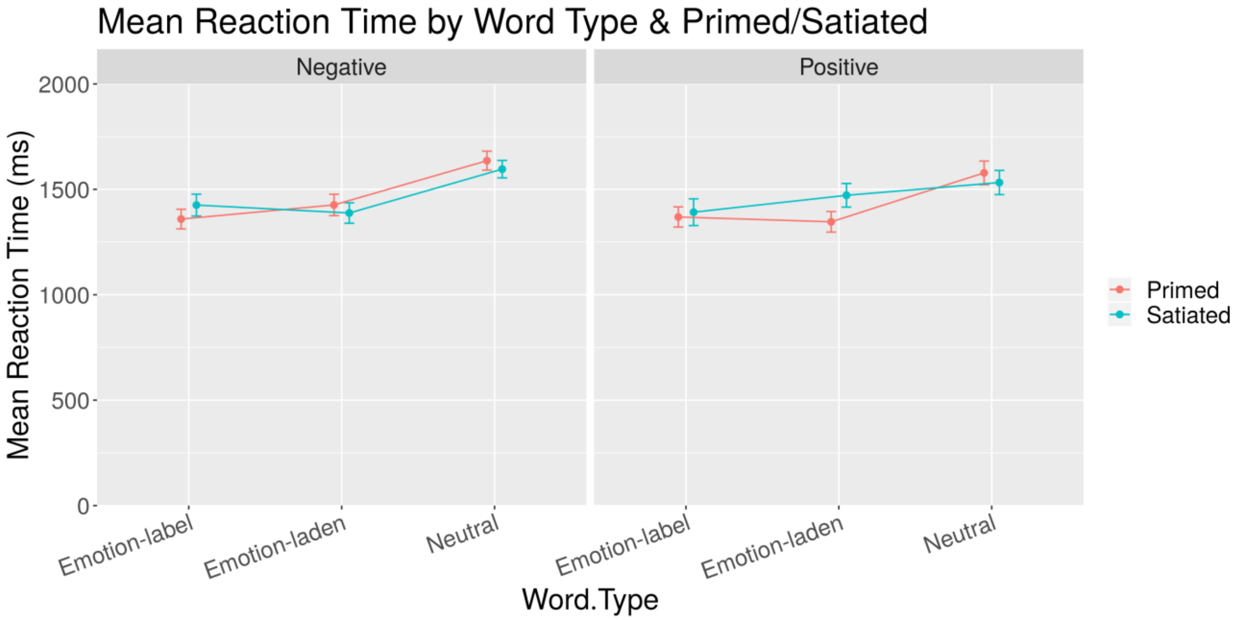


Figure 12. Interaction between word type, priming/satiation, and participant group, split by participant valence group with error bars showing standard error (including BDI & neutral)

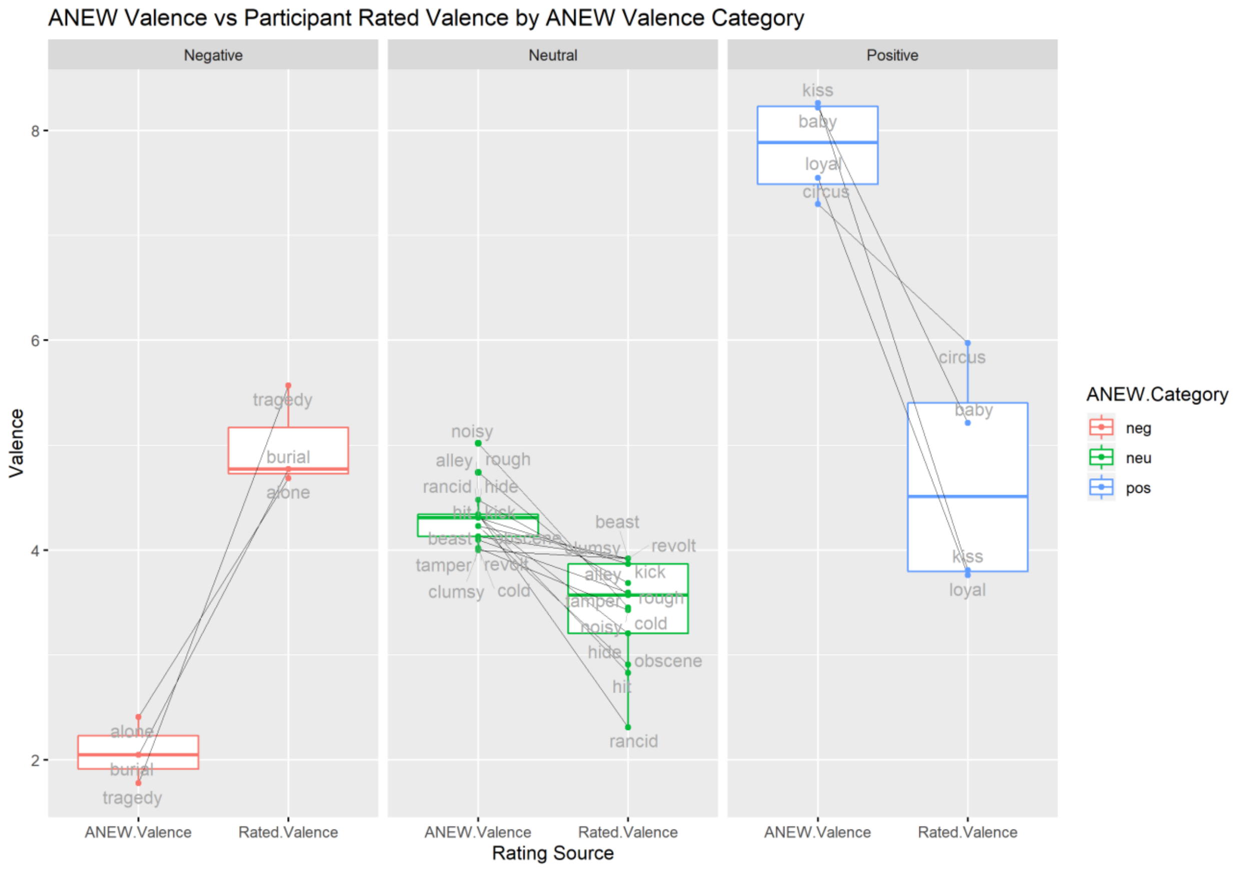
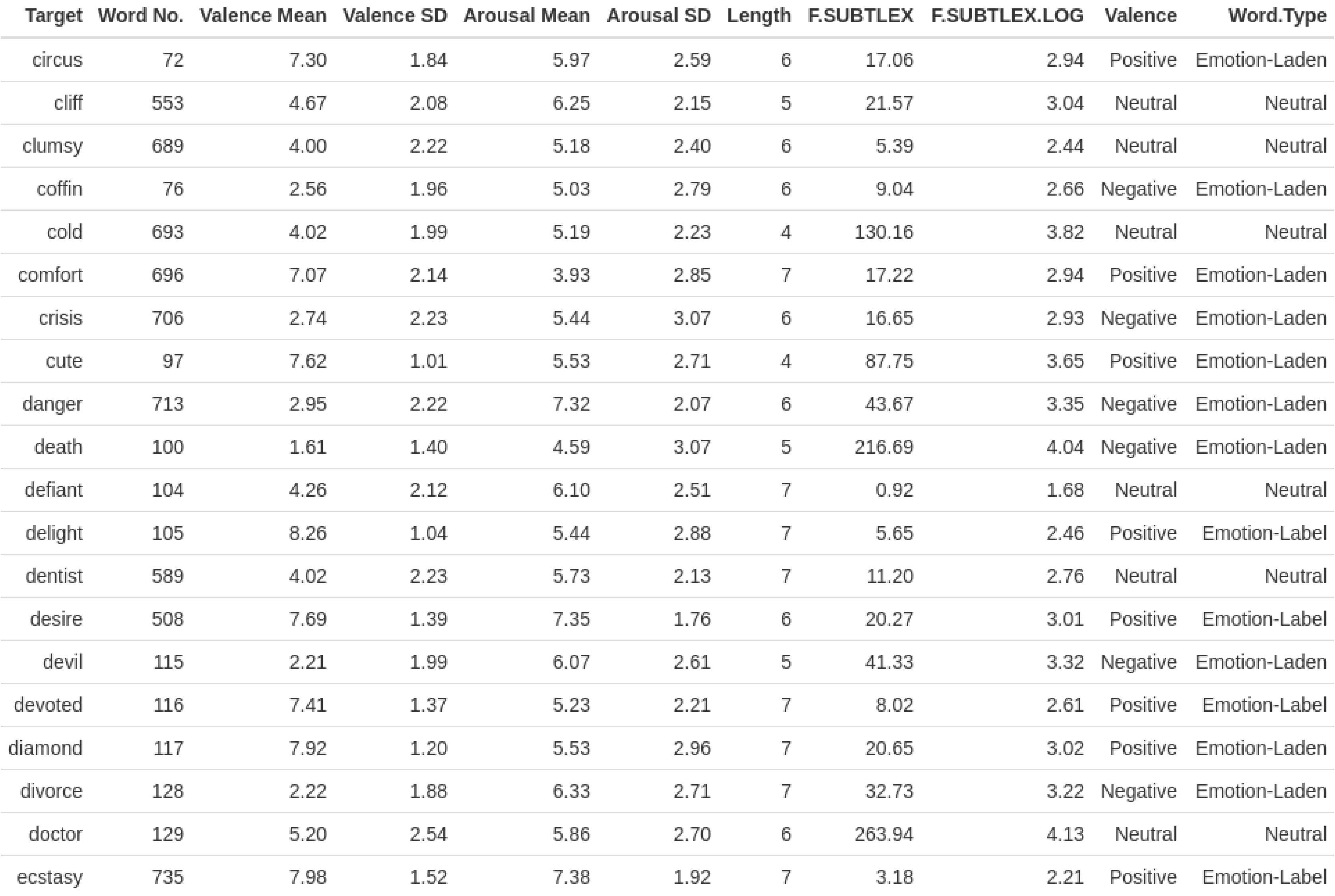


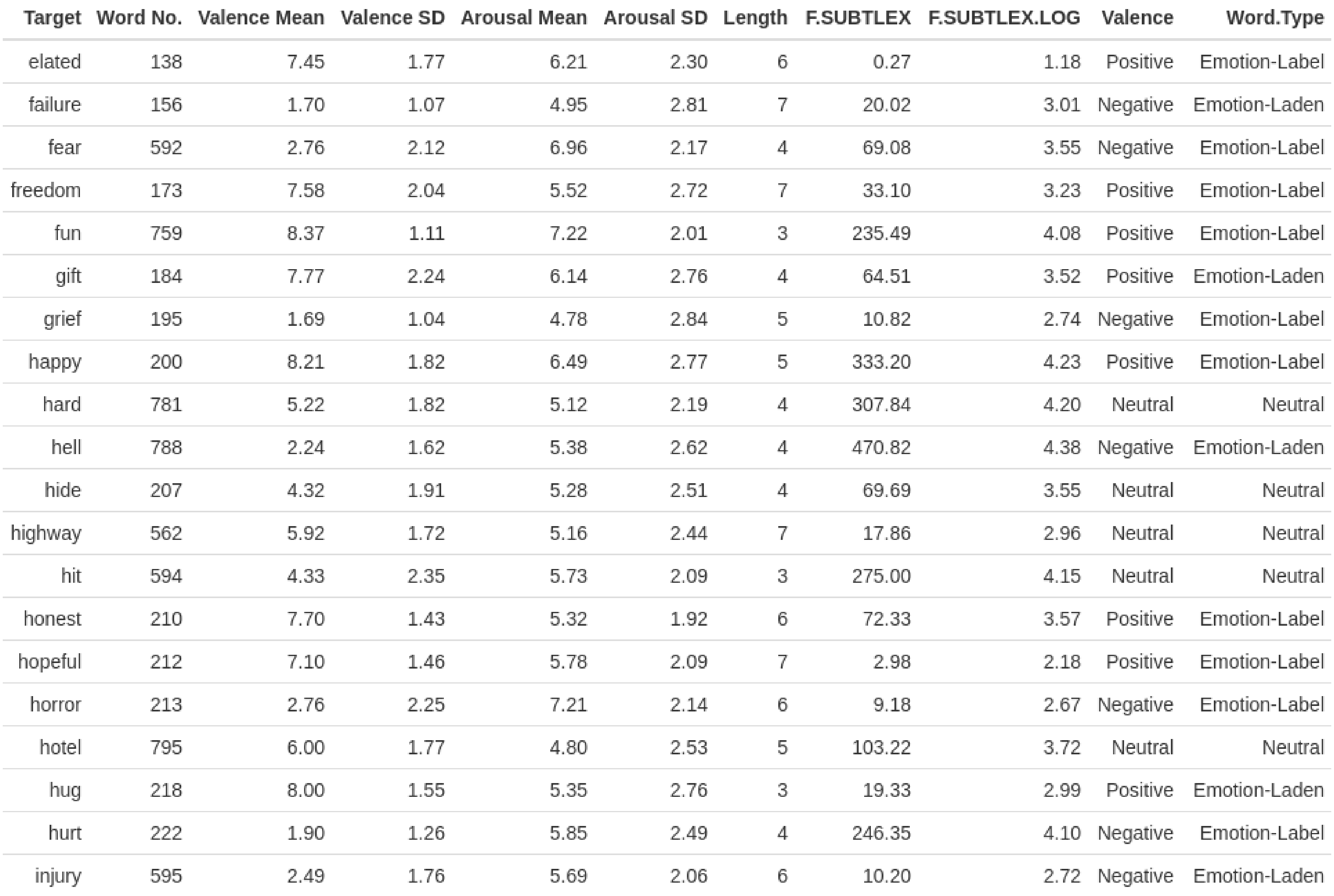
Figure 13. Categorical ANEW valence ratings vs participant provided valence ratings, where rated category differed from ANEW

Appendix 1. Stimuli words with characteristics taken from ANEW and ELP

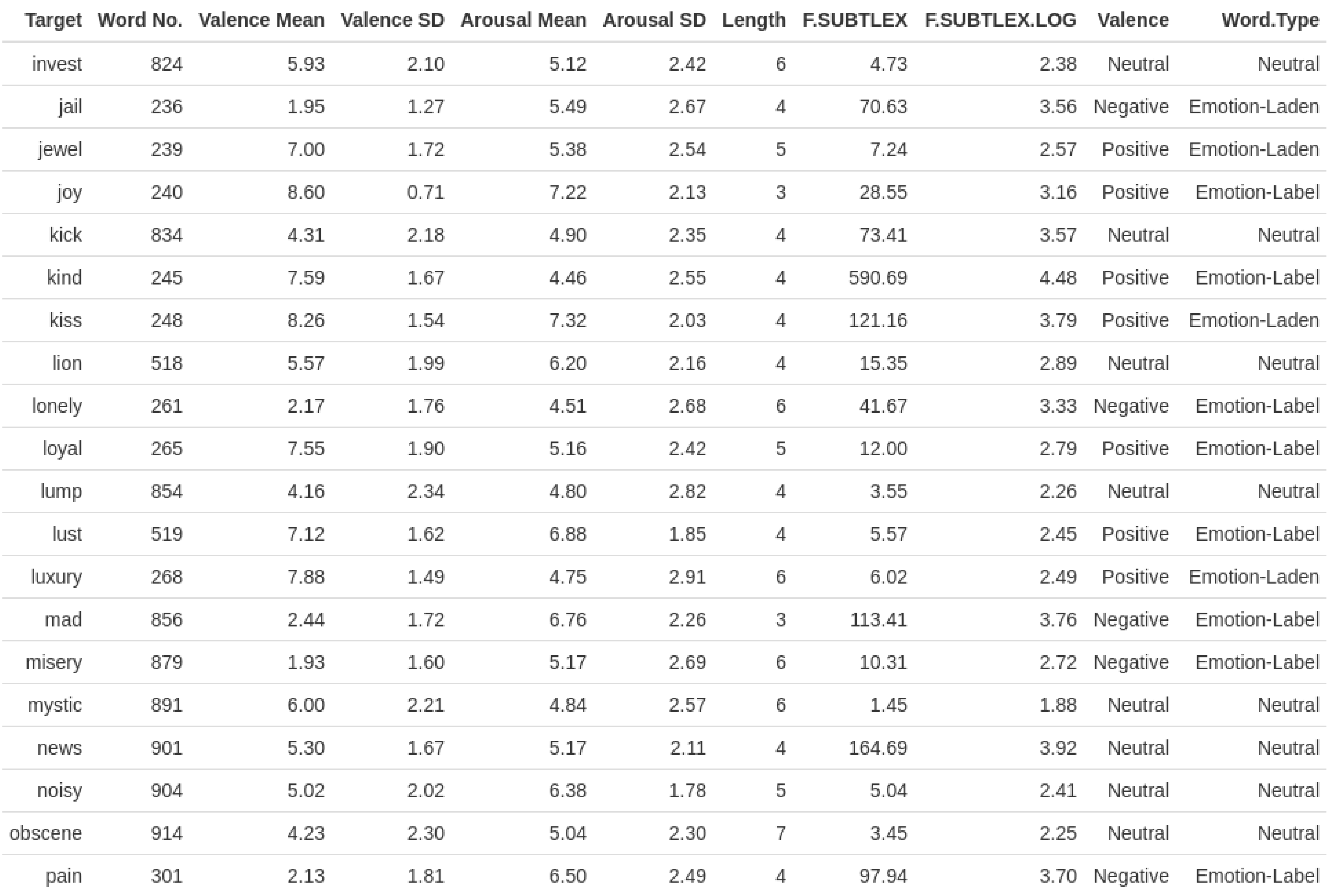
Target	Word No.	Valence Mean	Valence SD	Arousal Mean	Arousal SD	Length	F.SUBTLEX	F.SUBTLEX.LOG	Valence	Word.Type
abuse	1	1.80	1.23	6.83	2.70	5	10.25	2.72	Negative	Emotion-Label
ache	627	2.46	1.52	5.00	2.45	4	2.49	2.11	Negative	Emotion-Laden
afraid	8	2.00	1.28	6.67	2.54	6	247.67	4.10	Negative	Emotion-Label
alien	633	5.60	1.82	5.45	2.15	5	17.43	2.95	Neutral	Neutral
alley	637	4.48	1.97	4.91	2.42	5	16.29	2.92	Neutral	Neutral
alone	12	2.41	1.77	4.83	2.66	5	308.53	4.20	Negative	Emotion-Label
anger	17	2.34	1.32	7.63	1.91	5	19.43	3.00	Negative	Emotion-Label
annoy	20	2.74	1.81	6.49	2.17	5	2.51	2.11	Negative	Emotion-Label
army	23	4.72	1.75	5.03	2.03	4	85.69	3.64	Neutral	Neutral
aroused	24	7.97	1.00	6.63	2.70	7	2.22	2.06	Positive	Emotion-Label
baby	31	8.22	1.20	5.53	2.80	4	509.37	4.41	Positive	Emotion-Laden
beast	653	4.23	2.41	5.57	2.61	5	24.55	3.10	Neutral	Neutral
body	665	5.55	2.37	5.52	2.63	4	195.53	4.00	Neutral	Neutral
boxer	585	5.51	1.80	5.12	2.26	5	3.84	2.29	Neutral	Neutral
brave	668	7.15	1.64	6.15	2.45	5	31.71	3.21	Positive	Emotion-Label
bride	670	7.34	1.71	5.55	2.74	5	24.22	3.09	Positive	Emotion-Laden
burial	56	2.05	1.41	5.08	2.40	6	4.75	2.39	Negative	Emotion-Laden
cake	59	7.26	1.27	5.00	2.37	4	45.06	3.36	Positive	Emotion-Laden
cancer	60	1.50	0.85	6.42	2.83	6	22.33	3.06	Negative	Emotion-Laden
cheer	69	8.10	1.17	6.12	2.45	5	18.69	2.98	Positive	Emotion-Label



Target	Word No.	Valence Mean	Valence SD	Arousal Mean	Arousal SD	Length	F.SUBTLEX	F.SUBTLEX.LOG	Valence	Word.Type
circus	72	7.30	1.84	5.97	2.59	6	17.06	2.94	Positive	Emotion-Laden
cliff	553	4.67	2.08	6.25	2.15	5	21.57	3.04	Neutral	Neutral
clumsy	689	4.00	2.22	5.18	2.40	6	5.39	2.44	Neutral	Neutral
coffin	76	2.56	1.96	5.03	2.79	6	9.04	2.66	Negative	Emotion-Laden
cold	693	4.02	1.99	5.19	2.23	4	130.16	3.82	Neutral	Neutral
comfort	696	7.07	2.14	3.93	2.85	7	17.22	2.94	Positive	Emotion-Laden
crisis	706	2.74	2.23	5.44	3.07	6	16.65	2.93	Negative	Emotion-Laden
cute	97	7.62	1.01	5.53	2.71	4	87.75	3.65	Positive	Emotion-Laden
danger	713	2.95	2.22	7.32	2.07	6	43.67	3.35	Negative	Emotion-Laden
death	100	1.61	1.40	4.59	3.07	5	216.69	4.04	Negative	Emotion-Laden
defiant	104	4.26	2.12	6.10	2.51	7	0.92	1.68	Neutral	Neutral
delight	105	8.26	1.04	5.44	2.88	7	5.65	2.46	Positive	Emotion-Label
dentist	589	4.02	2.23	5.73	2.13	7	11.20	2.76	Neutral	Neutral
desire	508	7.69	1.39	7.35	1.76	6	20.27	3.01	Positive	Emotion-Label
devil	115	2.21	1.99	6.07	2.61	5	41.33	3.32	Negative	Emotion-Laden
devoted	116	7.41	1.37	5.23	2.21	7	8.02	2.61	Positive	Emotion-Label
diamond	117	7.92	1.20	5.53	2.96	7	20.65	3.02	Positive	Emotion-Laden
divorce	128	2.22	1.88	6.33	2.71	7	32.73	3.22	Negative	Emotion-Laden
doctor	129	5.20	2.54	5.86	2.70	6	263.94	4.13	Neutral	Neutral
ecstasy	735	7.98	1.52	7.38	1.92	7	3.18	2.21	Positive	Emotion-Label



Target	Word No.	Valence Mean	Valence SD	Arousal Mean	Arousal SD	Length	F.SUBTLEX	F.SUBTLEX.LOG	Valence	Word.Type
elated	138	7.45	1.77	6.21	2.30	6	0.27	1.18	Positive	Emotion-Label
failure	156	1.70	1.07	4.95	2.81	7	20.02	3.01	Negative	Emotion-Laden
fear	592	2.76	2.12	6.96	2.17	4	69.08	3.55	Negative	Emotion-Label
freedom	173	7.58	2.04	5.52	2.72	7	33.10	3.23	Positive	Emotion-Label
fun	759	8.37	1.11	7.22	2.01	3	235.49	4.08	Positive	Emotion-Label
gift	184	7.77	2.24	6.14	2.76	4	64.51	3.52	Positive	Emotion-Laden
grief	195	1.69	1.04	4.78	2.84	5	10.82	2.74	Negative	Emotion-Label
happy	200	8.21	1.82	6.49	2.77	5	333.20	4.23	Positive	Emotion-Label
hard	781	5.22	1.82	5.12	2.19	4	307.84	4.20	Neutral	Neutral
hell	788	2.24	1.62	5.38	2.62	4	470.82	4.38	Negative	Emotion-Laden
hide	207	4.32	1.91	5.28	2.51	4	69.69	3.55	Neutral	Neutral
highway	562	5.92	1.72	5.16	2.44	7	17.86	2.96	Neutral	Neutral
hit	594	4.33	2.35	5.73	2.09	3	275.00	4.15	Neutral	Neutral
honest	210	7.70	1.43	5.32	1.92	6	72.33	3.57	Positive	Emotion-Label
hopeful	212	7.10	1.46	5.78	2.09	7	2.98	2.18	Positive	Emotion-Label
horror	213	2.76	2.25	7.21	2.14	6	9.18	2.67	Negative	Emotion-Label
hotel	795	6.00	1.77	4.80	2.53	5	103.22	3.72	Neutral	Neutral
hug	218	8.00	1.55	5.35	2.76	3	19.33	2.99	Positive	Emotion-Laden
hurt	222	1.90	1.26	5.85	2.49	4	246.35	4.10	Negative	Emotion-Label
injury	595	2.49	1.76	5.69	2.06	6	10.20	2.72	Negative	Emotion-Laden



Target	Word No.	Valence Mean	Valence SD	Arousal Mean	Arousal SD	Length	F.SUBTLEX	F.SUBTLEX.LOG	Valence	Word.Type
invest	824	5.93	2.10	5.12	2.42	6	4.73	2.38	Neutral	Neutral
jail	236	1.95	1.27	5.49	2.67	4	70.63	3.56	Negative	Emotion-Laden
jewel	239	7.00	1.72	5.38	2.54	5	7.24	2.57	Positive	Emotion-Laden
joy	240	8.60	0.71	7.22	2.13	3	28.55	3.16	Positive	Emotion-Label
kick	834	4.31	2.18	4.90	2.35	4	73.41	3.57	Neutral	Neutral
kind	245	7.59	1.67	4.46	2.55	4	590.69	4.48	Positive	Emotion-Label
kiss	248	8.26	1.54	7.32	2.03	4	121.16	3.79	Positive	Emotion-Laden
lion	518	5.57	1.99	6.20	2.16	4	15.35	2.89	Neutral	Neutral
lonely	261	2.17	1.76	4.51	2.68	6	41.67	3.33	Negative	Emotion-Label
loyal	265	7.55	1.90	5.16	2.42	5	12.00	2.79	Positive	Emotion-Label
lump	854	4.16	2.34	4.80	2.82	4	3.55	2.26	Neutral	Neutral
lust	519	7.12	1.62	6.88	1.85	4	5.57	2.45	Positive	Emotion-Label
luxury	268	7.88	1.49	4.75	2.91	6	6.02	2.49	Positive	Emotion-Laden
mad	856	2.44	1.72	6.76	2.26	3	113.41	3.76	Negative	Emotion-Label
misery	879	1.93	1.60	5.17	2.69	6	10.31	2.72	Negative	Emotion-Label
mystic	891	6.00	2.21	4.84	2.57	6	1.45	1.88	Neutral	Neutral
news	901	5.30	1.67	5.17	2.11	4	164.69	3.92	Neutral	Neutral
noisy	904	5.02	2.02	6.38	1.78	5	5.04	2.41	Neutral	Neutral
obscene	914	4.23	2.30	5.04	2.30	7	3.45	2.25	Neutral	Neutral
pain	301	2.13	1.81	6.50	2.49	4	97.94	3.70	Negative	Emotion-Label

Target	Word No.	Valence Mean	Valence SD	Arousal Mean	Arousal SD	Length	F.SUBTLEX	F.SUBTLEX.LOG	Valence	Word.Type
poison	319	1.98	1.44	6.05	2.82	6	24.55	3.10	Negative	Emotion-Laden
pride	327	7.00	2.11	5.83	2.48	5	27.67	3.15	Positive	Emotion-Label
puppy	336	7.56	1.90	5.85	2.78	5	11.45	2.77	Positive	Emotion-Laden
rage	342	2.41	1.86	8.17	1.40	4	11.31	2.76	Negative	Emotion-Label
rancid	956	4.34	2.28	5.04	2.27	6	0.49	1.42	Neutral	Neutral
reptile	958	4.77	2.00	5.18	2.19	7	1.41	1.86	Neutral	Neutral
respect	354	7.64	1.29	5.19	2.39	7	71.45	3.56	Positive	Emotion-Label
revolt	357	4.13	1.78	6.56	2.34	6	1.55	1.90	Neutral	Neutral
reward	358	7.53	1.67	4.95	2.62	6	18.02	2.96	Positive	Emotion-Laden
robber	964	2.61	1.69	5.62	2.72	6	4.69	2.38	Negative	Emotion-Laden
rotten	365	2.26	1.37	4.53	2.38	6	17.47	2.95	Negative	Emotion-Label
rough	966	4.74	2.00	5.33	2.04	5	37.39	3.28	Neutral	Neutral
rude	366	2.50	2.11	6.31	2.47	4	22.06	3.05	Negative	Emotion-Label
sad	368	1.61	0.95	4.13	2.38	3	63.37	3.51	Negative	Emotion-Label
salute	370	5.92	1.57	5.31	2.23	6	7.25	2.57	Neutral	Neutral
scared	604	2.78	1.99	6.82	2.03	6	133.39	3.83	Negative	Emotion-Label
secure	381	7.57	1.76	3.14	2.47	6	24.33	3.09	Positive	Emotion-Label
selfish	382	2.42	1.62	5.50	2.62	7	15.90	2.91	Negative	Emotion-Label
snuggle	404	7.92	1.24	4.16	2.80	7	1.29	1.83	Positive	Emotion-Laden
storm	1000	4.95	2.22	5.71	2.34	5	30.86	3.20	Neutral	Neutral

Target	Word No.	Valence Mean	Valence SD	Arousal Mean	Arousal SD	Length	F.SUBTLEX	F.SUBTLEX.LOG	Valence	Word.Type
success	417	8.29	0.93	6.11	2.65	7	27.25	3.14	Positive	Emotion-Laden
swamp	1004	5.14	2.24	4.86	2.36	5	8.98	2.66	Neutral	Neutral
tamper	1006	4.10	1.88	4.95	2.01	6	0.49	1.42	Neutral	Neutral
tank	613	5.16	1.87	4.88	1.86	4	25.61	3.12	Neutral	Neutral
tease	1010	4.84	2.51	5.87	2.56	5	5.69	2.46	Neutral	Neutral
tragedy	447	1.78	1.31	6.24	2.64	7	14.18	2.86	Negative	Emotion-Laden
traitor	448	2.22	1.69	5.78	2.47	7	10.59	2.73	Negative	Emotion-Laden
trauma	616	2.10	1.49	6.33	2.45	6	17.04	2.94	Negative	Emotion-Laden
treat	1019	7.36	1.38	5.62	2.25	5	51.88	3.42	Positive	Emotion-Laden
triumph	451	7.80	1.83	5.78	2.60	7	4.65	2.38	Positive	Emotion-Laden
truck	577	5.47	1.88	4.84	2.17	5	72.86	3.57	Neutral	Neutral
trumpet	456	5.75	1.38	4.97	2.13	7	4.12	2.32	Neutral	Neutral
tumor	459	2.36	2.04	6.51	2.85	5	5.16	2.42	Negative	Emotion-Laden
unhappy	463	1.57	0.96	4.18	2.50	7	16.53	2.93	Negative	Emotion-Label
vampire	470	4.26	1.86	6.37	2.35	7	17.53	2.95	Neutral	Neutral
vanity	472	4.30	1.91	4.98	2.31	6	4.12	2.32	Neutral	Neutral
victim	618	2.18	1.48	6.06	2.32	6	47.73	3.39	Negative	Emotion-Laden
victory	475	8.32	1.16	6.63	2.84	7	21.45	3.04	Positive	Emotion-Laden
volcano	619	4.84	2.14	6.33	2.21	7	3.33	2.23	Neutral	Neutral
wealthy	488	7.70	1.34	5.80	2.73	7	7.37	2.58	Positive	Emotion-Laden