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Emotion effects during reading: Influence of an emotion target word on eye movements and processing

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Recently, Scott, O’Donnell and Sereno reported that words of high valence and arousal are processed with greater ease than neutral words during sentence reading. However, this study unsystematically intermixed emotion (label a state of mind, e.g., terrified or happy) and emotion-laden words (refer to a concept that is associated with an emotional state, e.g., debt or marriage). We compared the eye-movement record while participants read sentences that contained a neutral target word (e.g., chair) or an emotion word (no emotion-laden words were included). Readers were able to process both positive (e.g., happy) and negative emotion words (e.g., distressed) faster than neutral words. This was true across a wide range of early (e.g., first fixation durations) and late (e.g., total times on the post-target region) measures. Additional analyses revealed that State Trait Anxiety Inventory scores interacted with the emotion effect and that the emotion effect was not due to arousal alone.

Keywords: Emotion; Eye movement; Reading.

Several independent lines of research have found evidence that emotional stimuli have a processing advantage when compared to neutral stimuli. Emotional stimuli used in these studies are typically emotional words, with high arousal ratings and either very low or very high valence ratings (Bradley & Lang, 1999). Across these tasks, emotion has been found to have both beneficial and interference effects on goal completion. In all instances, emotional processing either helped or hindered task processing due to an apparent processing advantage for emotional stimuli. To date, there has been little inquiry into the question of emotional processing utilising eye-tracking methodology to find evidence of this processing advantage during normal silent reading (see e.g., Scott, O’Donnell, & Sereno, 2012). The current study investigated the processing of emotion and neutral words embedded within full neutral sentences by tracking the eye movements and fixation durations of participants.

Emotion effects

Researchers have noted an emotional influence on processing in several established cognitive tasks and effects, including visual search tasks (Hansen & Hansen, 1988), dot-probe tasks (Koster, Crombez,
Visual search literature has shown a similar processing advantage for emotion stimuli in the form of a pop-out effect (increasing visual array size does not increase RT; Treisman & Gelade, 1980) when using emotional imagery, such as negative faces (Frischen, Eastwood, & Smilek, 2008), phobic imagery (e.g., spiders) and threat-related imagery (e.g., guns; Brosch & Sharma, 2005; Öhman, Flykt, & Esteves, 2001). There has also been evidence of an emotional processing advantage with the dot-probe task where participants detect a visual dot probe following the simultaneous presentation of two stimuli. Participants are faster to react to the dot probe when it appears in the same location as a negative emotional stimulus (Lipp & Derakshan, 2005), including phobic spider images (Mogg & Bradley, 2006) and, more pertinent to the current study, threatening word stimuli (MacLeod, Mathews, & Tata, 1986), as well as positive emotion stimuli (Sutton & Altarriba, 2011). Attentional blink (AB; Chun & Potter, 1995) RSVP studies where a serial sequence of stimuli is presented visually for very brief durations (e.g., 50–150 ms) have also exhibited a negative emotion advantage. When two neutral targets are presented close together (approximately 180 ms or less), the accuracy of the report of the second target is reduced, but emotional stimuli do not experience this reduction in accuracy (De Martino et al., 2009; Maratos, Mogg, & Bradley, 2008; Trippe, Hewig, Heydel, Hecht, & Miltner, 2007).

The negative emotion advantage has also been observed with RSVP research into the repetition blindness (RB) effect. Investigations into RB are very similar to AB studies, but compare performance when the targets are identical and different (the RB effect is typically defined as the difference between accuracy in repeated trials and unrepeated trials) and also tend to make greater use of word stimuli rather than imagery stimuli. Typically, repeated targets are reported with significantly lower accuracy than unrepeated targets. Silvert, Naveteur, Honoré, Sequeira, and Boucart (2004) used negative emotion and neutral target word pairs and found that the RB effect was significantly larger for emotion words than for neutral words. Knickerbocker and Altarriba (2013) found a similar effect when presenting words in fully structured grammatical sentences that participants had to read on each trial, suggesting that the emotion advantage may extend beyond general perceptual processing advantages to advantages when processing words for the purpose of reading complex statements.

In general, affective priming studies have found an automatic response facilitation when primes match the valence of the target (positive or negative), participants are faster to complete a lexical decision task (LDT; Spruyt, Hermans, De Houwer, & Eelen, 2002), as well as a pronunciation task (Hermans, De Houwer, & Eelen, 1994). In these studies, participants are asked to view a prime word followed by a target word, and then either determine whether the target is a word or non-word, determine whether the target is negative or positive, or pronounce the target. While these studies are typically used to study the processing of emotion words and the structure of semantic memory, they do provide some insights into the reading of emotion words. Arguably, the prime-target relationship is similar to the relationship between the target and post-target regions of many eye-tracking studies. These affective priming studies provide some evidence that having meaningful emotion information in the target region can increase the speed with which post-target words are recognised and integrated into an emotional statement. The pronunciation studies further suggest that reading, whether out loud or in one’s head, will be sped up if the target is emotional and emotional information is present in the pre-target region.

The affective Stroop task also suggests that emotion words experience a processing advantage during reading (McKenna, 1986; McKenna & Sharma, 1995, 2004). In the Stroop task, participants are asked to view individual target words and
report the colour of the word, rather than pronounce the word itself. Several studies have reported significant levels of interference where reactions have increased due to the target being an emotion word. When considering the reading and processing of isolated word stimuli, the findings from several paradigms suggest a processing advantage for positive words (i.e., those with high arousal and high valence) over neutral words (Kakolewski, Crowson Jr., Sewell, & Cromwell, 1999; Kanske & Kotz, 2007; Kuchinke, Võ, Hofmann, & Jacobs, 2007; Schacht & Sommer, 2009; Scott, O’Donnell, Leuthold, & Sereno, 2009), as well as for negative words (i.e., those with high arousal and low valence) over neutral words (Kanske & Kotz, 2007; Kousta, Vinson, & Vigliocco, 2009; Nakic, Smith, Busis, Vythilinggam, & Blair, 2006; Schacht & Sommer, 2009; Tabert et al., 2001; Windmann, Daum, & Güntürkün, 2002).

Emotion effects in reading
Recently Scott et al. (2012) investigated the eye movements of participants reading sentences that contained emotional words. Eye-tracking methodology has been used for decades to measure ease of cognitive processing in the context of natural sentence reading with a high degree of sensitivity (Rayner, 1998, 2009). Scott et al. selected emotional words with high arousal that were either positive or negative from the Affective Norms of English Words (ANEW) database (Bradley & Lang, 1999). Words in ANEW are rated on 9-point arousal (1 = low and 9 = high) and valence (1 = negative emotional associations and 9 = positive emotional associations) scales. The emotional words were matched to neutral words and embedded as targets within full grammatical sentences. Scott et al. controlled for an exhaustive set of lexical variables including, word length, imageability and age of acquisition. Low frequency positive and negative emotional words had significantly faster first fixation durations, single fixation durations, gaze durations and total times than neutral words. However, when analysing high frequency words, only a positive emotion advantage was significant. Scott et al. argued that both positive and negative emotional words are easier to process than neutral words during sentence reading, but that this effect is modulated by word frequency.

Theoretical account of the emotion advantage
Theoretical accounts of the emotion effects obtained by the studies described above have emphasised the negative emotion processing advantage and minimised the importance of the less consistent positive emotion advantage. An evolutionary account utilising a two motivational system, approach-appetitive and withdrawal-aversive, has commonly been implemented to explain the results of emotion research (see Bradley, 2000). The explanation for the more commonly obtained negative emotion processing advantage has been based on the argument that survival is heavily related to fleeing, or withdrawing, from a potentially negative scenario. Thus, the withdrawal-aversive system is given processing priority and advantages over the approach-appetitive system and negatively valenced stimuli are processed more quickly than positively valenced stimuli. For example, the automatic vigilance account (Pratto & John, 1991) describes an evolutionarily obtained mechanism specifically for the early (e.g., pre-conscious) allocation of attention resources to negative emotional stimuli (see Kuperman, Estes, Brysbaert, & Warriner, 2014 for lexicosemantic and decision-response explanations of automatic vigilance), while more recent models have proposed a system where negative stimuli attract processing attention for a longer duration than positive or neutral stimuli (Fox, Russo, Bowles, & Dutton, 2001).

As can be seen in the emotion studies detailed above, these accounts largely ignore the consistent emotion advantage observed for positively valenced items, and therefore fall short of fully explaining the advantage of emotional items. Kousta et al. (2009) conducted several studies that supported an alternative account known as the motivated attention and affective states model (Lang, Bradley, & Cuthbert, 1990, 1997). Here, emotional stimuli capture attention regardless of valence polarity, because
emotional stimuli are motivationally significant. Positive and negative emotion stimuli capture attention earlier than neutral stimuli, as well as maintaining a processing advantage over neutral stimuli.

Kousta et al. (2009) proposed that some of the conflicting data on the positive emotion advantage were actually due to a lack of control of the lexical variable of items. The authors conducted an LDT study with positive, negative and neutral words that were matched on a number of lexical variables, including those not utilised in previous emotion research such as age of acquisition and familiarity. In support of the motivated attention and affective states account, Kousta et al. found a significant processing advantage for positively valenced and negatively valenced emotion words over neutral words when analysing both response time and accuracy data (there were no differences between emotion items). Further, when assessing the influence of valence and arousal using large-scale regression analyses and measures from the English Lexicon Project (ELP; Balota et al., 2002), valence was a significant predictor of performance but arousal was not a significant predictor when the regression models included valence.

**CURRENT STUDY**

As discussed previously, Scott et al. (2012) found evidence of a general emotion advantage during reading. However, the authors intermixed both emotion and emotion-laden words when creating their positive and negative emotional word conditions. Emotion words label a state of mind that can be experienced (e.g., happy or sad). Emotion-laden words do not refer to an emotion but rather to a concept that is associated with an emotional state (e.g., death or marriage). Previous research has indicated that emotion and emotion-laden words are processed differently by participants in cognitive paradigms (Altarriba & Basnight-Brown, 2011; Knickerbocker & Altarriba, 2011, 2013). These studies have presented evidence that supports a position that the direct connection between emotion words and emotion concepts led to observable differences in participant performance.

Altarriba and Basnight-Brown (2011) utilised an Affective Simon Task to explore for differences between emotion and emotion-laden words. Participants viewed individual words and indicated whether the words were nouns or adjectives. The task required the participants respond “positive” when viewing a noun and “negative” when viewing an adjective. Typically, a congruency effect is obtained, where participants are significantly faster to respond when there is a match between the valence of the word and the correct response (e.g., a negative emotion adjective and a response of negative) than when there is a mismatch (e.g., a negative emotion noun and a response of positive). The authors created separate emotion and emotion-laden conditions, and found a congruency effect for both positive and negative emotion-laden words, but found the effect for only negative emotion words. This divergent pattern of effects was the first evidence of a difference between emotion and emotion-laden words.

Knickerbocker and Altarriba (2013) conducted a follow-up RB study that further examined the emotion RB effect observed by Silvert et al. (2004). Participants viewed words embedded within symbol streams and full grammatical sentences. Emotion, emotion-laden and neutral target pairs were presented as either repeated or unrepeated. Again, the emotion effect was observed as the RB effect for repeated emotion targets was significantly larger than that observed for repeated neutral words. However, the emotion RB effect was also significantly larger than the emotion-laden RB effect, which did not differ from the neutral RB effect. It appeared that the emotion and emotion-laden words were not processed similarly as they were read within symbol distractors or full sentences. The direct connections between emotion words and emotion concepts increased the saliency of emotion words and led to a significantly larger RB effect. The indirect connection between emotion-laden words and emotion concepts did not increase the saliency of emotion-laden words,
and led to a similar pattern of performance in emotion-laden and neutral words.

The embodied account of semantic representation (Vigliocco, Meteyard, Andrews, & Kousta, 2009) may provide support for the interpretation of the differing emotion and emotion-laden effects detailed by Knickerbocker and Altarriba (2013) and Altarriba and Basnight-Brown (2011). Kousta, Vigliocco, Vinson, Andrews, and Del Campo (2011) described semantic representations as including experiential and linguistic information. Under this model, emotion is considered another type of experiential information. If language development is contingent upon word-to-world mappings (Gleitmann, Cassidy, Nappa, Papafragou, & Trueswell, 2005) where early experiential information is used to determine semantic representations of abstract words, emotion and emotion-laden words should have differing patterns of experiential information relating to emotional states of mind. Semantic representations of emotion words should include experiential information that incorporates observations of emotional states in others and the self, which are crucial in developing a stable meaning and comprehension of emotion words. In fact, Kousta et al. (2011) went so far as to provide evidence that emotion words tend to be learned earlier than other abstract words due to more readily available emotional experiences and observations. However, emotion-laden words should have experiential information that is more similar to other abstract words, or even concrete words, and develop emotional experiential information over time. For example, when learning the emotion-laden word “jail”, the concrete experiential information that can be easily observed should form the initial semantic representation (e.g., images of jails, images of prisoners). As the abstract elements of the word “jail” become understood, the semantic representation should become more nuanced and experiential data related to emotional states such as depression or anger should become linked to the semantic representation as peripheral information.

The primary goal of the current study was to investigate the emotion processing advantage during reading without the inclusion of any emotion-laden words. We were interested in determining if an emotion advantage would be present for both positive and negative emotion words when compared to neutral words. To assess the emotion advantage when reading, eye movements when reading positive emotion, negative emotion and neutral words were investigated with a more thorough set of measures that included indicators of early and later processing and measures from both target and post-target regions. These additional measurements allowed the study to determine whether the emotion advantage was isolated to early or late processing. In addition, they added potential confidence to the findings of the study, as measurements from multiple sentence regions should have aided in the interpretation of the data. Experiment 1 compared the reading of sentences with either positive emotion or neutral target words, while Experiment 2 compared eye movements when reading sentences with either negative emotion or neutral target words. Due to the findings from AB studies with “high anxiety” participants, we examined whether the emotion effects can be moderated by the readers’ depression and/or anxiety level as measured by the Beck Depression Inventory (BDI-II; Beck, Steer, & Brown, 1996) and the State Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983), respectively.

**EXPERIMENT 1**

**Participants**

There were 64 students from Skidmore College who participated in the current experiment. All participants were native English speakers, with normal (or corrected to normal) vision, and received course credit as compensation. We report how we determined our sample size, all data exclusions, all manipulations and all measures in the study.

**Apparatus**

Eye movements were tracked and recorded with an Eyelink 1000 (SR Research, ON, Canada) interfaced with a Pentium 4 (Intel Corp., Santa
Clara, CA, USA) computer. The eye tracker sampled and recorded the position of the reader's eye every millisecond. Each participant was seated 83 cm away from an LCD monitor (View-Sonic Corp., Walnut, CA, USA) such that four character positions equalled 1 degree of visual angle. The reader's head movements were minimised by the use of a chin rest during this experiment. Although sentence reading took place binocularly, eye movements were only recorded from the reader's right eye. Sentences were presented in 14-point Courier New font.

Design and stimuli

Thirty-six positive emotion words and 36 neutral words were selected from the ANEW database (Bradley & Lang, 1999) to serve as target words in the current study. The ANEW database provides measures of both valence (a measure of the strength and direction of the emotional associations for a given word) and arousal (a measure of the amount of excitement or energy associated with a given word). For example, positive emotion words have high valence ratings, while neutral words tend to have moderate valence ratings, and negative emotion words have low valence ratings. Further, emotion words tend to have high arousal ratings while neutral words have moderate or low arousal ratings. Only words with high valence and arousal ratings that referred to a specific emotional state of mind (e.g., happy or joyous) were selected as positive emotion words, and only words with moderate valence ratings and low arousal ratings (and did not refer to an emotional state) were selected as neutral words. The positive emotion words had significantly higher valence ratings than the neutral words, $t(70) = 19.23$, $p < .001$, as well as significantly higher arousal ratings, $t(70) = 6.23$, $p < .001$. The extremity of the valence scores for both the positive and negative word types was compared to ensure that both groups of words were similarly different from neutral. The absolute value of the difference of valence scores from 5 (the centre of the valence scale) was computed and compared for positive and negative words. There was no difference in the valence extremity of positive (2.65) and negative words (2.81), $t(70) = 1.41$, $p = .16$.

The positive emotion and neutral words were selected to be matched on several measures (taken from the ELP, Balota et al., 2002) that have previously been shown to influence eye movements and performance on reading tasks. There were no significant differences between the positive emotion and neutral word groups on measures including word frequency (KF, Kučera & Francis, 1967, HAL, Lund & Burgess, 1996, and SUBTLEX, Brysbaert & New, 2009), word length, orthographic neighbourhood size, mean naming RT and mean LDT RT. The means and standard deviations for the normative measures of both experiment target conditions (as well as the $p$ values for each comparison) can be viewed in Table 1. Both word groups included 12 nouns, 12 verbs and 12 adjectives.

Experimental sentences were created by embedding the target words into single line sentences. Positive emotion and neutral words were paired (for a total of 36 word pairs), and two sentences were created for each target word pair (for a total of 72 experimental sentences) such that both sentences were understandable and grammatical when using either the positive emotion or neutral target word. For example, in the sentence “The artist couldn't find the highway/acceptance he was looking for in New York”, either target word grammatically fits in the frame. The sentences in the experiment were counterbalanced such that each participant viewed all 36 positive emotion word targets and all 36 neutral word targets in unique sentences (each participant viewed each sentence frame only once). Word type (positive emotion word or neutral word) was a two-level within-subjects and within-item manipulation. Sentences were created with target words appearing approximately in the middle (and never the word-initial or the word-final letter) of the sentences. The number of other emotional terms used in the sentences was kept to a minimum due to the emotion word type manipulation of the target words. There were a total of 24 noun target sentences, 24 adjective target sentences, and 24
verb target sentences. The experimental sentences for Experiment 1 can be found in Appendix A.

**Normative data**

Before the collection of eye-tracking data for the current study, the experimental sentences were normed for understandability and predictability to ensure that each target word pair fit equally well within their given sentence frames but was not predictable from sentence context. In the understandability norm, 22 participants rated how well each target word fit within its sentence frame on a scale of 1–7 (1 = not understandable; 7 = very understandable). Items were counterbalanced such that each participant saw each target word and each sentence frame only once. All of the target words in both target conditions were judged to be highly understandable (positive emotion target \( M = 5.30 \); neutral target \( M = 5.27 \)) and importantly, there were no significant differences between the understandability ratings of sentence frames containing positive emotion targets and those containing neutral targets (\( p = .89 \)). In the predictability norm, 21 participants were given the beginning of each sentence frame (up to the target word) and asked to predict the next word in the sentence. Target words were not highly predictable from the preceding context of the sentence frame and there was no significant difference between the predictability of positive emotion targets (\( M = 0.06\% \)) and the neutral targets (\( M = 0.45\%, \ p = .13 \)).

**Procedure**

Each participant was informed of the experimental procedure through both written and verbal instructions. Before participating in the eye-tracking experiment, each participant was asked to complete both the BDI-II (Beck et al., 1996) and the State Version of the STAI (Spielberger et al., 1983). The BDI is a 21-item questionnaire where participants select one of several statements for each item to indicate the feelings and behaviours that they have had during the past 2 weeks. It is designed to measure symptoms of depression such as hopelessness, irritability, feelings of guilt, loss of energy and changes in appetite or sleep habits. Possible scores on the scale range from 0 to 63 with higher scores indicating more severe depressive symptoms. The STAI is a 20-item questionnaire where participants use a 4-point Likert scale to indicate how they are feeling (e.g., anxious, upset, jittery, worried) at that very moment to assess anxiety level. A number of items are reverse scored (e.g., joyful, content, relaxed). Possible scores range from 20 to 80, with higher scores indicating greater anxiety. Participants completed both of these questionnaires, in random order, and then began the eye-tracking portion of the experiment.

| Table 1. Mean lexical characteristics for the items used in Experiments 1 and 2 |
|---------------------------------|--------|--------|--------|
|                                  | Neutral | Positive | Negative |
|                                  | \( M \) | \( SD \) | \( M \) | \( SD \) | \( M \) | \( SD \) |
| Valence                          | 5.49    | 0.37    | 7.64    | 0.56    | 2.19    | 0.42    | <.001   |
| Arousal                          | 4.22    | 0.72    | 5.66    | 1.19    | 5.82    | 1.06    | <.001   |
| Length (no. of letters)         | 5.94    | 1.57    | 6.42    | 1.76    | 6.25    | 1.93    | .52     |
| Word frequency (Kučera–Francis) | 29.39   | 27.13   | 35.44   | 49.08   | 23.97   | 26.15   | .40     |
| Word frequency (log HAL)         | 8.85    | 1.32    | 8.33    | 1.82    | 8.43    | 1.34    | .30     |
| Word frequency (SUBTLEX)         | 21.96   | 26.85   | 82.27   | 217.65  | 45.46   | 68.93   | .16     |
| Orthographic neighbourhood size  | 2.83    | 3.74    | 2.28    | 3.61    | 2.94    | 5.15    | .77     |
| Mean naming RT (ms)             | 619.77  | 51.08   | 630.68  | 59.31   | 636.49  | 57.24   | .44     |
| Mean LDT RT (ms)                | 637.28  | 55.91   | 642.27  | 80.55   | 652.45  | 73.11   | .65     |

Note: Kučera–Francis word frequencies are reported in frequencies per million.
The eye-tracking experiment began by aligning the eye tracker and calibrating the machine. Calibration was only accepted if the maximum error was less than 0.30 of visual angle (corresponding to <1 character). Following the calibration, the participant read eight practice sentences to become familiar with the trial procedure. After the completion of the practice session, the experimental sentences appeared individually, in randomised order, on the centre row of the monitor. Participants were told to read each sentence silently and at a natural comfortable pace. After completing each sentence, participants pressed a button on a response box to end the trial, calibration accuracy was confirmed, and the next trial was initiated by the researcher. Following 33% of the trials, a comprehension question appeared to ensure (and to measure the extent to which) participants were not skimming sentences without actually reading them. Participants were instructed to use a response box to choose between two potential responses. Questions always referred to the immediately preceding experimental sentence. All participants included in the analyses did well on the comprehension questions ($M = 99.0\%$, range = 96–100%). Upon completing the final trial of the experiment, participants were given a written debriefing form. The experiment required approximately 60 minutes.

RESULTS

Trials were eliminated from data analysis if the eye tracker lost track of the eye or the participant blinked while fixating on the pre-target word, target word or post-target word. In cases in which adjacent fixations fell within one character of one another, and one of the fixations was short (less than 80 ms), the two fixations were pooled (see Rayner, 1998). In addition, extremely short (less than 80 ms) isolated fixations and extremely long (greater than 1000 ms) fixations were eliminated from the data. Altogether, 4.4% of the data were removed.

Multiple eye movement measures were analysed to explore the ease of processing positive emotion words relative to neutral words. These measures included (1) early, or first pass, measures of processing on the target word, (2) late measures of processing on the target word and (3) measures of processing difficulty seen in other regions after leaving the target word. Early measures included (a) first fixation duration (the duration of the first fixation that readers made on the target word), (b) single fixation duration (the duration of the first fixation on the target word given that the reader made only one fixation on it during first pass reading), (c) gaze duration (the amount of time the reader spent on the target word before leaving it to the left or right), (d) landing position (the distance from the beginning of the word, in character positions, that the reader landed on the target word) and (e) skipping rate (the percentage of trials in which the reader skipped the target word during first pass reading). Late measures included (f) total time (the total time spent on the target word, including any regressions back to the word after leaving it), (g) regressions in (the percentage of trials in which the reader went back to the target word after leaving it) and (h) second pass time (the amount of time spent on the second pass reading of the target word). Measures of processing difficulty seen in other regions after leaving the target word included (i) spillover (the duration of the first fixation made after leaving the target region), (j) the first fixation duration on the post-target region (defined as the two-word region following the target word, see Johnson, 2009; Perea & Pollatsek, 1998), (k) the gaze duration on the post-target region, (l) the total time spent on the post-target region and (m) the percentage of regressions made out of the post-target region. The means for each of the eye movement measures as a function of target word condition are shown in Table 2.

Analyses were conducted using the lme4 package for linear mixed-effects models (Bates, Maechler, & Bolker, 2011) in R, an open-source programming language and environment for statistical computing (R Development Core Team, 2011, v.2.13.1). For each scalar-dependent measure (e.g., fixation durations, number of fixations), a linear mixed-effects model (Baayen, Davidson, & Bates, 2008) was fit to the data with random
Table 2. Means on each eye movement measure, as a function of target word condition, for Experiment 1

<table>
<thead>
<tr>
<th></th>
<th>Neutral</th>
<th>Positive</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Target region</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First pass measures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>First fixation</td>
<td>238*</td>
<td>233</td>
</tr>
<tr>
<td>Single fixation</td>
<td>241*</td>
<td>236</td>
</tr>
<tr>
<td>First pass (gaze)</td>
<td>267†</td>
<td>261</td>
</tr>
<tr>
<td>Landing position</td>
<td>2.15**</td>
<td>2.33</td>
</tr>
<tr>
<td>Skipping rate</td>
<td>12.8%</td>
<td>11.8%</td>
</tr>
<tr>
<td><strong>Late measures</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total time</td>
<td>321**</td>
<td>311</td>
</tr>
<tr>
<td>Regressions in</td>
<td>16.6%*</td>
<td>14.3%</td>
</tr>
<tr>
<td>Second pass time</td>
<td>46.3*</td>
<td>38.2</td>
</tr>
<tr>
<td><strong>Post-target region</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spillover</td>
<td>246**</td>
<td>238</td>
</tr>
<tr>
<td>First fixation</td>
<td>251*</td>
<td>244</td>
</tr>
<tr>
<td>First pass (gaze)</td>
<td>378**</td>
<td>364</td>
</tr>
<tr>
<td>Total time</td>
<td>463*</td>
<td>440</td>
</tr>
<tr>
<td>Regressions out</td>
<td>14.7%*</td>
<td>12.8%</td>
</tr>
</tbody>
</table>

Note: All durations are in ms. For the first pass (gaze), go past time, and total time measures, trials without any fixations are not included. Second pass time includes trials with no fixations (counted as a 0 ms duration). Spillover includes the duration of the first fixation made after leaving the target region (including both forward and regressive saccades).

*0.05 ≤ p < .10; *.01 ≤ p < .05; **.001 ≤ p < .01; ***p < .001.

intercepts for participants and items and with target word type as a fixed effect centred on its mean. Fixation duration measures were log transformed to ensure a more normal distribution. P values were calculated based on Markov Chain Monte Carlo sampling (Bates, 2005). The binary-dependent measures (i.e., skipping rate, percentage of regressions into the target word and percentage of regressions out of the post-target region) were analysed using mixed-effects logistic regression, with the same random and fixed effects (Jaeger, 2008). P values for these binary measures were calculated using the z-distribution.

In looking at the early measures of processing, readers spent less time fixating on positive emotion words than on neutral words. First fixation durations ($b = −0.019, t = −2.2, p = .03$) and single fixation durations ($b = −0.021, t = −2.1, p = .03$) were shorter on positive emotion words than on neutral words. Gaze durations showed this same trend, although the effect was only marginally significant ($b = −0.020, t = −1.8, p = .07$). Furthermore, readers landed further into the target word when it was positive than when it was neutral ($b = 0.181, t = 3.13, p = .002$). There was no difference, however, in skipping rates as a function of target word condition ($b = 0.110, z = 1.15, p = .249$).

Differences in eye movement measures were also seen in later measures of processing after leaving the target word, both on the target word itself as well as in the post-target region. Readers, who made fewer regressions back to positive emotion words ($b = −0.196, z = 2.12, p = .034$), had shorter second pass reading times on positive emotion words ($b = −8.01, t = −2.62, p = .009$), and spent less total time on positive emotion words when compared to neutral words ($b = −0.034, t = −2.62, p = .009$). Furthermore, readers spent less time on the first fixation after leaving the target word either to the right or to the left (spillover) when the target word was a positive emotion word than when it was neutral ($b = −0.029, t = −3.0, p = .003$). In looking at eye movement measures on the post-target region, reading times were significantly shorter following positive emotion words than neutral words. This effect was seen in first fixation durations ($b = −0.022, t = −2.4, p = .016$), gaze durations ($b = −0.034, t = −2.64, p = .008$) and total times ($b = −0.039, t = −3.12, p = .002$). Readers also made fewer regressions out of the post-target region following a positive emotion word than a neutral word ($b = −0.184, z = −1.95, p = .05$).

Due to the fact that positive emotion words differ from neutral words not only in their valence but also their arousal, further analyses were conducted to examine the effect of valence above and beyond the effect due to arousal rating alone. Linear mixed-effects analyses were conducted on each of the eye movement measures with each item’s arousal rating from the ANEW database entered as a predictor variable (centred about the mean). Target word type was included as a fixed effect and random intercepts were again used for both participants and items. The effects of target word type were similar to those just described. As before, the main effect of target word type was
statistically significant in the analyses of first fixation duration \( (p = .01) \), single fixation duration \( (p = .008) \), landing position \( (p = .047) \), total time \( (p < .001) \), percentage of regressions in \( (p = .003) \), second pass times \( (p = .002) \) and total time on the post-target region \( (p = .026) \). Interestingly, there was a significant interaction between target word type and arousal ratings in the total time on the target word measure \( (b = -0.050, t = -2.42, p = .016) \) such that the emotion effect was stronger for words of high arousal \( (14 \text{ ms effect}) \) than for words of low arousal \( (4 \text{ ms effect}) \). The main effect of target word type was again marginally significant in gaze durations \( (p = .05) \), and not significant in skipping rates \( (p = .25) \). Some of the effects of target word type that were previously seen in the post-target region (specifically on the first fixation duration, gaze duration, regressions out and spillover measures) were no longer statistically significant \( (\text{all } p > .11) \), although arousal ratings were not a significant predictor in these cases either \( (\text{all } p > .14) \). Thus, the effects reported earlier are not driven by arousal only, but are instead due to the emotional content of the stimuli which includes both high arousal coupled with extreme valence.

### The influence of BDI and STAI

In order to explore the possible influences that depression and anxiety levels have on the above reported effects, two additional sets of linear mixed-effects analyses were conducted on these same dependent measures with either participants’ BDI score or their STAI score included in the model as continuous predictors. Each score was centred about its mean. Again, target word type was included as a fixed effect and random intercepts were used for both participants and items. Tables 3 and 4 report the linear mixed-effects estimates for these additional models. When BDI

<table>
<thead>
<tr>
<th>Word type</th>
<th>BDI score</th>
<th>Word type × BDI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Target region</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First pass measures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>First fixation</td>
<td>-0.0192*</td>
<td>0.0007</td>
</tr>
<tr>
<td>Single fixation</td>
<td>-0.0205*</td>
<td>0.0009</td>
</tr>
<tr>
<td>First pass (gaze)</td>
<td>-0.0196†</td>
<td>0.0017</td>
</tr>
<tr>
<td>Landing position</td>
<td>0.1807**</td>
<td>0.0059</td>
</tr>
<tr>
<td>Skipping rate</td>
<td>-0.1075</td>
<td>0.0070</td>
</tr>
<tr>
<td>Late measures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total time</td>
<td>-0.0342**</td>
<td>0.0017</td>
</tr>
<tr>
<td>Regressions in</td>
<td>-0.1957**</td>
<td>0.0069</td>
</tr>
<tr>
<td>Second pass time</td>
<td>-8.0098**</td>
<td>0.1237</td>
</tr>
<tr>
<td><strong>Post-target region</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spillover</td>
<td>-0.0292**</td>
<td>0.0006</td>
</tr>
<tr>
<td>First fixation</td>
<td>-0.0222*</td>
<td>0.0021</td>
</tr>
<tr>
<td>First pass (gaze)</td>
<td>-0.0341**</td>
<td>0.0032</td>
</tr>
<tr>
<td>Total time</td>
<td>-0.0392**</td>
<td>0.0023</td>
</tr>
<tr>
<td>Regressions out</td>
<td>-0.1876*</td>
<td>-0.0129</td>
</tr>
</tbody>
</table>

*Note: The estimates for skipping rate, regressions in, and regressions out are reported in log odds where a negative estimate reflects a decrease in log(odds) of a regression or a skip in the positive emotion condition compared to the neutral condition. Estimates for landing position are reported in number of character positions where a positive estimate reflects a further landing position (in characters) in the positive emotion condition compared to the neutral condition. For second pass time, estimates are reported in milliseconds where a negative estimate reflects a decrease in reading time (in milliseconds) in the positive emotion condition compared to the neutral condition. The estimates for all other reading time measures are reported in log milliseconds where a negative estimate reflects a decrease in reading time (in log milliseconds) in the positive emotion condition compared to the neutral condition.†.05 ≤ p < .10; *.01 ≤ p < .05; **.001 ≤ p < .01; ***p < .001.
was included into the model with target word type, the effect of target word type was the same as reported above across each of the dependent measures. However, the main effect of BDI score was never significant (all ps > .36) nor did it significantly interact with target word type (all ps > .11). Similarly, when STAI was included into the model with target word type, the effect of target word type was again the same as reported above across each dependent measure, but the main effect of STAI score was never significant (all ps > .08) nor was the interaction (all ps > .17).

DISCUSSION

The results from Experiment 1 consistently point to a positive emotion processing advantage. Across multiple early- and late-dependent measures, readers were able to process positive emotion words with greater ease than neutral words. These findings are consistent with previous research that shows that emotional words impact response times in cognitive tasks and are processed more quickly than neutral words (Kakolewski et al., 1999; Kanske & Kotz, 2007; Kousta et al., 2009; Kuchinke et al., 2007; Schacht & Sommer, 2009). Specifically, the current study supported the motivated attention and affective states (Lang et al., 1990, 1997) proposed by Kousta et al. (2009).

Of further interest, however, was the fact that neither BDI scores nor STAI scores were significantly related to the processing measures or significantly interacted with the target word type manipulation. Thus, it appears that positive emotion words are easier to process than neutral words regardless of the level of depressive or anxiety symptoms that a reader has.
EXPERIMENT 2

While the target words in Experiment 1 were either positive emotion words or neutral words, the purpose of Experiment 2 was to explore the effects of negative emotion words on eye movements during sentence reading. The same design and procedure that was used in Experiment 1 was again used, but each sentence contained either a neutral target word or a negative emotion word. Again, emotion-laden words were excluded from the stimulus list, and BDI and STAI scores were calculated for each participant so that we could assess the influence of depression and anxiety levels on the effects.

Participants

There were 78 students from the Skidmore Psychology Research Pool who participated in the current experiment. All participants were native English speakers, with normal (or corrected to normal) vision, and received course credit as compensation.

Apparatus

Utilising the same equipment and procedures as Experiment 1, eye movements were tracked and recorded with an Eyelink 1000 (SR Research) interfaced with a Pentium 4 (Intel Corp.) computer.

Design and stimuli

Thirty-six negative emotion words were selected from ANEW (Bradley & Lang, 1999) and paired with the same 36 neutral words from Experiment 1 to serve as target words in Experiment 2. Only words with low valence and high arousal ratings that referred to a specific emotional state of mind (e.g., sad or depressed) were selected as negative emotion words. The negative emotion words had significantly lower valence ratings than the neutral words, $t(70) = 34.34$, $p < .001$, as well as significantly higher arousal ratings, $t(70) = 7.38$, $p < .001$. Both word groups included 12 nouns, 12 verbs and 12 adjectives.

Following the same matching procedure as in Experiment 1, the negative emotion and neutral words were selected to be matched on several measures taken from ELP (Balota et al., 2002). There were no significant differences between the negative emotion and neutral word groups on measures including word frequency (KF, Kučera, & Francis, 1967, HAL, Lund & Burgess, 1996, and SUBTLEX, Brysbaert & New, 2009), word length, orthographic neighbourhood size, mean naming RT and mean LDT RT. The means and standard deviations for the norm measures of both experiment target conditions (as well as the $p$ values for each comparison) can be viewed in Table 1.

Experimental sentences were created using the same procedure and sentence characteristics as in Experiment 1. The experimental sentences for Experiment 2 can be found in Appendix B.

Normative data

The experimental sentences were normed for understandability and predictability to ensure that each target word pair fit equally well within their given sentence frames following the norming procedures as used in Experiment 1. From the ratings of 20 individuals, all target words in both conditions were judged to be highly understandable (negative emotion target $M = 5.23$; neutral target $M = 5.46$), with no significant differences between the understandability ratings of sentence frames containing negative emotion targets and those containing neutral targets ($p = .13$). From the ratings of 20 additional individuals, target words in both conditions were not highly predictable from the preceding context of the sentence frame (negative emotion target $M = .42$%; neutral target $M = .35$, $p = .85$).

Procedure

The experimental procedure was the same as that used in Experiment 1, including the administration of the BDI and STAI prior to the eye-tracking experiment. Experimental sentences now contained either a negative emotion or neutral target word. All participants again did well on the
comprehension questions ($M = 98.9\%$, range = 92–100%).

RESULTS

Data were trimmed using the same procedures outlined in Experiment 1, leading to the removal of 4.1% of the data. Linear mixed-effects modeling was again used to analyse the various eye movement measures, which included measures of (1) early, or first-pass, measures of processing on the target word, (2) late measures of processing on the target word and (3) measures of processing difficulty seen in other regions after leaving the target word. The means for each of the eye movement measures as a function of target word condition are shown in Table 5.

In looking at the early measures of processing, readers spent less time fixating on negative emotion words than on neutral words. First fixation durations ($b = −0.021$, $t = −2.7$, $p = .007$) and single fixation durations ($b = −0.020$, $t = −2.3$, $p = .02$) were shorter on negative emotion words than on neutral words. There was no significant difference, however, in gaze durations, landing positions or skipping rates as a function of target word condition (all $p$s $> .25$).

Differences in eye movement measures were also seen in some of the later measures of processing. Readers, who made fewer regressions back to negative emotion words ($b = −0.335$, $z = −3.89$, $p < .001$), had shorter second pass reading times on negative emotion words ($b = −14.39$, $t = −3.88$, $p < .001$), and spent less total time on negative emotion words when compared to neutral words ($b = −0.043$, $t = −3.54$, $p < .001$). Readers also made fewer regressions out of the post-target region following a negative emotion word than a neutral word ($b = −0.338$, $z = −3.50$, $p < .001$). However, the effect of target word type was not significant in the spillover measure or on any of the other fixation duration measures on the post-target region (all $p$s $> .27$).

Again, due to the fact that negative emotion words differ from neutral words not only in their valence but also their arousal, further analyses were conducted to examine the effect of valence above and beyond the effect due to arousal rating alone. Linear mixed-effects analyses were conducted on each of the eye movement measures with each item's arousal rating from the ANEW database entered as a predictor variable (centred about the mean). Target word type was included as a fixed effect and random intercepts were again used for both participants and items. The effects of target word type were similar to those just described. As before, the main effect of target word type was statistically significant in the analyses of first fixation duration ($p = .02$), single fixation duration ($p = .04$), total time ($p < .001$), percentage of regressions in ($p = .03$) and second pass times ($p = .01$). The main effect of target word type was again not significant in gaze durations, landing positions, skipping rates or in any fixation duration measure in the post-target region (all $p$s $> .05$). There was, however, a significant interaction between target word type and arousal ratings in

<table>
<thead>
<tr>
<th>Target region</th>
<th>Neutral</th>
<th>Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>First pass measures</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First fixation</td>
<td>248**</td>
<td>242</td>
</tr>
<tr>
<td>Single fixation</td>
<td>250*</td>
<td>244</td>
</tr>
<tr>
<td>First pass (gaze)</td>
<td>285</td>
<td>284</td>
</tr>
<tr>
<td>Landing position</td>
<td>2.53</td>
<td>2.50</td>
</tr>
<tr>
<td>Skipping rate</td>
<td>10.9%</td>
<td>12.0%</td>
</tr>
<tr>
<td><strong>Late measures</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total time</td>
<td>349***</td>
<td>332</td>
</tr>
<tr>
<td>Regressions in</td>
<td>14.2%***</td>
<td>10.8%</td>
</tr>
<tr>
<td>Second pass time</td>
<td>56.3***</td>
<td>41.5</td>
</tr>
<tr>
<td><strong>Post-target region</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spillover</td>
<td>244</td>
<td>245</td>
</tr>
<tr>
<td>First fixation</td>
<td>249</td>
<td>251</td>
</tr>
<tr>
<td>First pass (gaze)</td>
<td>370</td>
<td>371</td>
</tr>
<tr>
<td>Total time</td>
<td>448</td>
<td>442</td>
</tr>
<tr>
<td>Regressions out</td>
<td>11.1%***</td>
<td>8.3%</td>
</tr>
</tbody>
</table>

*Note: All durations are in ms. For the first pass (gaze), go past time and total time measures, trials without any fixations are not included. Second pass time includes trials with no fixations (counted as a 0 ms duration). Spillover includes the duration of the first fixation made after leaving the target region (including both forward and regressive saccades).

*$.01 \leq p < .05$; **$.001 \leq p < .01$; ***$p < .001$. 

Table 5. Means on each eye movement measure, as a function of target word condition for Experiment 2
gaze durations on the target word \((b = -0.036, t = -2.11, p = .03)\) such that the emotion effect was stronger for words high in arousal (5 ms effect) than for words low in arousal (2 ms effect). The effect of target word type previously seen in the percentage of regressions out of the post-target region was no longer significant \((p = .13)\), although arousal ratings were not a significant predictor in this case either \((p = .32)\). Thus, the effects reported earlier are not driven by arousal only, but are instead due to the emotional content of the stimuli which includes both high arousal coupled with extreme valence.

### The influence of BDI and STAI

As in Experiment 1, the influence of depression and anxiety levels on these reported effects was explored by including these factors as fixed effects in the linear mixed-effects models. Tables 6 and 7 display the linear mixed-effects estimates for each of these models. When BDI scores were included into the model along with target word type, the main effect of BDI score was significant only in the landing position measure \((b = -0.024, t = -2.39, p = .02)\) where those with higher BDI scores tended to land closer to the beginning of the target words than those with lower BDI scores. The main effect of STAI score was not significant in any of the other dependent measures \((all \; p > .12)\), nor was the interaction between factors \((all \; p > .14)\).

When STAI was included into the linear mixed-effects model along with target word type, there was a significant main effect of STAI score in the landing position measure \((b = -0.016, t = -2.18, p = .03)\) where those with higher STAI scores tended to land closer to the beginning of the target words than those with lower STAI scores. The main effect of STAI score was not
significant for any of the other dependent measures (all \( p > .09 \)). Of particular interest, however, was the presence of a statistically significant interaction between STAI score and target word type in a number of dependent measures. These primarily included the early fixation duration measures on the target words. That is, there was a significant interaction in first fixation durations (\( b = -0.003, t = -2.3, p = .02 \)), single fixation durations (\( b = -0.003, t = -2.7, p = .007 \)) and gaze durations (\( b = -0.004, t = -3.11, p = .002 \)). Furthermore, the interaction was significant in the total time measure (\( b = -0.004, t = -2.59, p = .010 \)). Although overall, individuals spent less time on the negative emotion words than the neutral words, the nature of this interaction was such that this effect was even stronger for those individuals who scored high on the STAI. That is, individuals were able to more easily process the negative words when they were in a more anxious mood. None of the other interactions approached significance (all \( p > .21 \)).

**DISCUSSION**

Although the effects for negative emotion words were not as robust across eye movement measures as they were for positive emotion words, readers did show facilitation in both early and late measures. Again, these findings are consistent with previous studies that report greater processing ease for emotion words (specifically, negative emotion words) relative to neutral words (Kanske & Kotz, 2007; Kousta et al., 2009; Nakic et al., 2006; Schacht & Sommer, 2009; Tabert et al., 2001; Windmann et al, 2002), as well as the motivated attention and affective states (Kousta et al., 2009; Lang et al., 1990, 1997).
While again BDI did not significantly interact with target word type, it is important to note that STAI did. The BDI is typically used as a measure of depression, while the STAI is used as an indicator of anxiety. The finding that the STAI was related to performance, but the BDI was not in line with the cognitive profiles of individuals with anxiety and depression conditions (Sylvester et al., 2012). The nature of this interaction was such that individuals were able to more easily process the negative words when they were in a more anxious mood. This interaction was only seen in the early measures of processing on the target word (first fixation, single fixation and gaze duration), as well as in the total time measure. However, it should be noted that although the direction of the interaction was the same in the other late measures (percentage of regressions into the target word and second pass times), the interactions here were not statistically significant. Thus, it appears that the interaction seen in the total time measure is driven by the first pass reading times on the target words rather than the re-reading times. So, the increased benefit that anxious individuals have in processing negative emotion words occurs only very early in the time course of processing the word. This interaction is in line with previous research from AB, which has indicated that individuals with high anxiety are more likely to perceive and report negative and phobic stimuli (Trippe et al., 2007).

GENERAL DISCUSSION

These findings extend those of Scott et al. (2012) who looked primarily at early effects of emotion on the processing of target words. While Scott et al. found emotion effects in first fixation durations, single fixation durations and gaze durations on the target word, the current study also demonstrated long-lasting effects of emotion that appear not only in these early measures but also in later measures on both the target word, and on the post-target region. Further, while Scott et al. (2012) intermixed both emotion and emotion-laden words when creating emotion conditions, the findings shown in the current study reflect only the effects of emotion words. As previous research has indicated that emotion and emotion-laden words are processed differently by participants in cognitive paradigms (Altarriba & Basnight-Brown, 2011; Knickerbocker & Altarriba, 2013; Sutton & Altarriba, 2011), future research should explore the isolated effects of emotion-laden words on processing during sentence reading. The interaction with word frequency obtained by Scott et al. may be due to the emotion-laden words intermixed with their emotion stimuli. Follow-up studies investigating positive and negative emotion-laden words would be beneficial to this question and are currently being designed and run within our laboratory.

Experiments 1 and 2 were able to highlight a difference between the processing advantage of positive and negative emotion words in individuals with elevated levels of anxiety. While there were no significant interactions between STAI score and performance with positive emotion targets, a significant interaction was obtained with negative emotion targets. Participants with high anxiety scores exhibited an even larger processing advantage for negative emotion words. It appears as though having elevated anxiety levels primed negative emotions. This led participants with high anxiety scores to have even shorter viewing durations for negative target words when compared to neutral target words. This interaction effect is particularly interesting when considering the findings of the previously described AB investigations (De Martino et al., 2009; Maratos et al., 2008). The increased processing of negative emotion stimuli by high anxiety participants led to shorter fixations in the present study and higher recall rates in the AB studies. This effect cannot be explained by differences in the valence or arousal extremity of the positive and negative emotion words, as both word types exhibited valence and arousal levels of similar difference from the centre of the valence and arousal scales.

In general, the emotion advantage observed here with eye movements was similar to the effects found with other cognitive tasks (e.g., the RSVP task, the dot-probe task and the visual search task).
and supported the general emotion processing advantage predicted by the motivated attention and affective states model (Kousta et al., 2009; Lang et al., 1990, 1997). The shorter fixation durations suggest that participants can process emotional items in less time than neutral stimuli, similar to the effects found in AB and visual search studies. The current study suggests that the semantic processing of emotion words was significantly faster than that of neutral words, which can explain affective priming and the interference caused by emotional words on the Stroop task. The emotion advantage discovered in the present study extends the previous findings of an emotion processing advantage, by providing measurements of the effect as it influences eye movement behaviours rather than a single recall or RT measurement. The patterns of eye movements during the reading of emotion words were similar to those anticipated by the emotion advantage observed in previous research.

**Theoretical account of emotion advantage**

The emotion effects discovered in Experiment 2 did provide evidence for automatic vigilance of negative emotion stimuli (Pratto & John, 1991). Recall that an emotion advantage was found for negative words, but more importantly the emotion effect interacted with STAI levels. A withdrawal-aversive system giving processing priority to negatively valenced stimuli over neutral stimuli should result in participants with elevated anxiety levels exhibiting larger emotion effects, as well as the observed negative emotion advantage. In addition, the late processing effects were supportive of the longer attention duration for negative stimuli described by Fox et al. (2001). However, these models emphasised the emotion advantage for negative stimuli, while suggesting minimal effects for positive stimuli, and failed to account for the results of Experiment 1. Greater evidence for the general vigilance of emotion stimuli regardless of valence polarity was obtained by Experiments 1 and 2. The motivated attention and affective states account (Kousta et al., 2009; Lang et al., 1990, 1997), which holds that emotion stimuli capture attention regardless of valence polarity, was a better fit of the data. The significant effects in early measures of processing were evidence of initial perceptual advantages, but the significant effects in late measures are less clear for delayed disengagement. The continued emotion effect may imply that emotional stimuli are still receiving a processing advantage, but measures such as post-target region total reading time were significantly faster in the positive and negative conditions. If the emotion targets continued receiving processing attention, it did not slow the processing of the remainder of the sentence but rather sped up participants’ ability to process the entire sentence and integrate a meaning.

**Theoretical account of emotion and emotion-laden distinction**

The current study provided an account of the differing semantic representations of emotion and emotion-laden words. Recall that while both wordtypes are emotional, the semantic representations of emotion words are directly connected to information regarding emotional states of mind, while the semantic representations of emotion-laden words contain weaker indirect connections to emotional states of mind. This explanation was framed within the embodied account of abstract word representation (Kousta et al., 2011; Vigliocco et al., 2009). While the current study does provide evidence for a general emotion advantage to both positive and negative words (necessary for the embodied account), it does not directly provide evidence of differences between emotion and emotion-laden words. Future eye-tracking research should utilise a similar paradigm, but include emotion-laden wordtypes as target conditions. While there was evidence that emotion words capture attention from early and later measures of processing, emotion-laden words may exhibit a different pattern. The emotional connections of the semantic representations of emotion-laden words may ultimately lead to a similar processing advantage (albeit a potentially weaker effect), but the advantage may be limited to later measures of processing. The indirect and
weaker connections to emotional experiential information could isolate the processing advantage in emotion-laden words to late measures such as regressions back to the target region and post-target region total reading time. In addition, the current study did not directly compare positive and negative emotion words. Future designs could be developed to directly compare not only positive and negative emotion words but also positive and negative emotion-laden words.


**APPENDIX A (EXPERIMENT 1)**

1. Allison thought the *noisy/gentle* animal was looking for food at the campsite.
2. Ben wanted to adopt the *noisy/gentle* puppy he saw at the pet store.
3. Yesterday, there was a *blond/nice* doorman who helped me carry my things inside.
4. Clarissa watched the *blond/nice* teenager hand a toy to the crying child.
5. Doug watched the *limber/grateful* acrobat thank the crowd for attending.
6. While at the YMCA, the *limber/grateful* gymnast used the new equipment.
7. Even on busy days, the *patient/jolly* conductor waited for everyone to board the train.
8. During the holidays, the *patient/jolly* elf handed out toys to every child.
9. During the show, the *quiet/awed* elf handed out toys to every child.
10. From the capital building, the *quiet/awed* politician watched the sunrise.
11. We clapped as the *key/elated* player made the winning shot.
12. The audience listened as the key/elated soloist finished the song.
13. I listened to the stiff/happy mayor present his new policy.
14. At his retirement, the stiff/happy general gave a speech.
15. The bronze statue of the iron/brave soldier stood in the park.
16. The book had a(n) iron/brave robot as a main character.
17. The new building looked alien/terrific across the skyline.
18. Modern art always seems so alien/terrific to me because of the free flowing forms.
19. Despite being so young, the sheltered/friendly child went out of his way to make friends.
20. At the rock concert, the sheltered/friendly teenager met diverse people.
21. The first grader drew a yellow/joyful bird sitting in a tree.
22. The child pets the yellow/joyful cat purring on her lap.
23. Hank hired the custom/thankful painter who had lost his job.
24. I helped the custom/thankful cabinet maker find several new clients.
25. The chef changed the menu increasing the amount of butter/bliss in every dish.
26. The farmer thought butter/bliss was necessary to get through the day.
27. Many tourists found that the statue/kindness in the city was amazing.
28. Jake told me he did not expect the statue/kindness he received.
29. Laura wanted to have the appliance/joy she saw in the commercial on television.
30. Michael believed that the new appliance/joy he found was exactly what he needed.
31. The family thinks the museum/excitement this afternoon will be too much for grandpa.
32. Penny told me to check out the museum/excitement in the park this weekend.
33. My mother emphasised the importance of privacy/optimism in having a balanced life.
34. The teacher stated that some privacy/optimism was important for healthy living.
35. The doctor said I need more salad/enjoyment in my life to be healthier.
36. You can never have too much salad/enjoyment at the dinner party.
37. The couple found their old chair/passion as they visited their first home together.
38. Nora found her chair/passion about a year ago.
39. Steven was trying to find some highway/acceptance in Los Angeles.
40. The artist could not find the highway/acceptance he was looking for in New York.
41. Jean wanted to increase the level of detail/ecstasy included in her paintings.
42. Writers must work to inject detail/ecstasy into their literary works.
43. My guests got a little basket/merry at the Christmas party this weekend.
44. We may get a little basket/merry at the holiday celebration.
45. The news reported on the umbrella/hopeful company that opened in Seattle.
46. The rainy town wanted the umbrella/hopeful manufacturer to increase production.
47. The tenured professor gave his poster/proud presentation at the conference.
48. The teacher thought that Josh was a poster/proud boy because of his community service.
49. The company's actions this week will rock/thrill their investors and creditors.
50. The author's new novel will rock/thrill the critics and many readers.
51. The birthday clown plans to spray/fascinate the children with his water gun.
52. The orca whales at Sea World always spray/fascinate the entire crowd.
53. Erin's parents thought she would bake/love the food that was at the family reunion.
54. The Italian chef will probably bake/love pizza until the day he dies.
55. The huge fireworks display will rattle/dazzle the younger children in the audience.
56. The explosions in the action movie will rattle/dazzle the viewers at the premier.
57. The teacher watched the older student elbow/soothe the younger child during recess.
58. Regina tried to elbow/soothe her boyfriend during the fight.
59. It is important to invest/cheer for your child's future goals.
60. I prefer to invest/cheer with people that I know.
61. The science lecture will activate/delight the curious minds in the audience.
62. The strong aroma of perfume will activate/delight the shoppers’ sense of smell.
63. The sheriff is going to circle/secure the area around the crime scene.
64. The Secret Service will circle/secure the perimeter before the senator arrives.
65. Tim always used to concentrate/hope to finish his work early every day.
66. The debate team will concentrate/hope to make it to the state championship.
67. The experienced nurse will coast/comfort patients through the pre-operation procedures.
APPENDIX B (EXPERIMENT 2)

1. Billy tried to sell the custom/useless toolbox to his nephew.
2. Jean saved money to buy the custom/useless bike that no one else at the store liked.
3. Everyone knew that Craig was stiff/nervous when he spoke in front of the whole class.
4. Usually, Franklin was too shy and stiff/nervous to play guitar in front of other people.
5. Sadly, Rachel always felt sheltered/afraid and was never an outgoing person.
6. After growing up in a town, Sean was sheltered/afraid and did not think he could live in a city.
7. Ursula was forced to tell the noisy/cruel child that he could not yell on the bus.
8. The little boy was noisy/cruel and had to be sent to his room.
9. Ashley tried to comfort her blond/sad friend, who was upset about his dead cat.
10. While in the store, I saw a blond/sad child crying because he was lost.
11. The observant teacher told the quiet/unhappy toddler to play with the other children.
12. Even at a young age, Todd was quiet/unhappy and had trouble meeting new people.
13. At the basketball practice, the key/distressed player argued with the coach.
14. The boss just fired the key/distressed salesman for being late to work every day.
15. Carrie was paid to paint the iron/terrible sculpture that is in front of the school.
16. We decided to remove the iron/terrible gates that surrounded the entire property.
17. Even when trapped by the police, the patient/guilty robber was able to remain calm and escape.
18. Jeff could not believe the patient/guilty parent was ignoring the crying child.
19. The coach called to see if the limber/sick athlete could play in the game on Saturday.
20. Zachary was watching the limber/sick child upset his parents by climbing the jungle gym.
21. In art class, the child drew a yellow/lonely stick figure on a blank sheet of paper.
22. When I looked up the yellow/lonely, sun was the only thing in the sky.
23. The story described a small, alien/helpless creature who had landed here from outer space.
24. George was awoken by a small alien/helpless figure drowning in his backyard pool.
25. Helen watched the older student elbow/hurt the other child during an argument.
26. At the game, the boy did not mean to elbow/hurt the player on the other team.
27. Every holiday, I return home and bake/hate the dinner that the family eats together.
28. I am pretty sure that Kevin will bake/hate the sugar cookie mix from the grocery store.
29. Lisa is not sure about the room and will paint/despise it if we decide to move into this house.
30. Ned informed me that he will paint/despise the coffee table even if I like it.
31. The new young street gang will circle/fear us if we face them in their territory.
32. The cowboys will likely circle/fear the Native Americans if they attack the fort.
33. Victor really did not mean to spray/upset the girls as he washed his car in their driveway.
34. The cook is planning to play a joke and spray/upset the troublesome busboy with flat soda.
35. Paula always found that the highway/agony was the worst in the evening.
36. Will hoped that he could avoid the highway/agony for the rest of the work week.
37. The lawyer fought hard for the privacy/depression of his clients to be noted by the court.
38. Faith argued with Tom about privacy/depression because he was not respecting her feelings.
39. The buyer was not expecting the detail/gloom found in every room in the house.
40. The art critic disliked the detail/gloom found in the paintings.
41. Cathy immediately reported the poster/hatred and arguments she found on the message board.
42. Groups of people displayed their poster/hatred as they shouted at the criminals.
43. Theresa did not like the salad/jealousy she had at her friend’s house.
44. Though the restaurant was a success, the salad/jealousy still made the owner unhappy.
45. The director was concerned about the statue/horror in the first scene of the scary movie.
46. I certainly did not expect the statue/horror that you made me see today.
47. Alex typically had a lot of butter/pain in the morning at breakfast.
48. Many people have too much butter/pain in their daily lives to be healthy.
49. Beth would soon forget about the appliance/grief her family had at the farm house.
50. The realtor could actually view the appliance/grief as he peered into the vacant home.
51. The family talked about the chair/anger that was a nuisance and always in the way.
52. The discussion focused on the chair/anger that Carol got during her divorce from Phil.
53. The teacher did not like the children’s museum/rage she saw on the field trip.
54. The mayor did not like the town’s museum/rage and tried to fix it.
55. I ignored Robert’s lecture about my umbrella/misery because he was repeating himself.
56. A book about the history of the umbrella/misery in a rainy town would not sell very well.
57. The little boy seemed to ignore the basket/loneliness that his new friend had.
58. The teacher commented on the basket/loneliness that the new student had.
59. The heavy metal band will rock/disappoint the entire audience with their new songs.
60. These new findings are going to rock/disappoint the scientific and medical community.
61. Charlotte tried not to invest/detest the gifts that she inherited from her parents.
62. Jeremy thinks that very few employees invest/detest the money that they make.
63. The worker will coast/offend at work if he is not supervised.
64. My dad has a tendency to coast/offend while driving the car.
65. Darla wanted to concentrate/scorn our efforts to update the equipment.
66. Bob’s employer wanted to concentrate/scorn his efforts towards obtaining a promotion.
67. I am warning you that Roxanne will rattle/betray your friendship and trust at some point.
68. Tom has a dark past and will rattle/betray the ethical standards of this company.
69. The art teacher tried to patent/humiliate my new design.
70. The professor openly attempted to patent/humiliate my ideas about time travel.
71. I think the flower is going to activate/irritate my allergies and give me a runny nose.
72. The strong aromas from the restaurant will probably activate/irritate my sense of smell.