PROCESSING ANGRY AND HAPPY FACES: THE EFFECT OF PERCEPTUAL LOAD AND FAMILIARITY

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No study to date has examined whether familiar and unfamiliar emotional distracter faces are processed under conditions of high perceptual load. The present study observed the effects of perceptual load (low, high) and familiarity (unfamiliar, familiar) on the processing of angry, happy, and neutral distracter faces. Fifty six participants volunteered for a word-valence task in which they identified a happy or angry target word among 1 non-word (low perceptual load) or 5 non-words (high perceptual load) while ignoring a peripheral distracter face. Prior to performing the word-valence task, half of the participants were familiarized with the distracter faces and the other half were not. The results indicated that response times (RTs) for incongruent trials (e.g., happy face, angry word) were longer than those of congruent trials (e.g., angry face, angry word) under low perceptual load in both the familiar and unfamiliar groups. Under high perceptual load, this difference was present in the familiar group, but not in the unfamiliar group. Furthermore, the analyses suggested that happy, and not angry faces, were being processed under low perceptual load.

Accepted by: ______________________, Chair

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Processing Angry and Happy Faces: The Effect of Perceptual Load and Familiarity

Research has shown that negative stimuli are attended to more readily than positive stimuli (Kern, Libkuman, & Otani, 2002; Ortony, Turner, & Antos, 1983). When presented with negative stimuli, an individual is likely to react in a manner different to that of positive or neutral stimuli in a number of different ways including greater response latencies (Dahl, 2001; Estes & Adelman, 2008; Pratto & John, 1991; Van Dillen & Koole, 2009; Wentura, Rothermund, & Bak, 2000), benefits to recall (Kern et al., 2002; Pratto & John, 1991; Robinson-Riegler & Winton, 1996), and recognition (Ortony et al., 1983). This enhanced attention to negative stimuli, or vigilance, is believed to have an evolutionary basis in which we attend to negative stimuli more readily so that we may more effectively react to anything costly or harmful in our environment. Kahneman and Tversky (1984) called this phenomenon *loss aversion*, which says that we assign more value to negative stimuli so that we may avoid undesirable outcomes.

Attention to Negative Verbal Stimuli

According to a number of studies, word valence alone appears to be a strong determinant of the vigilance we experience where valence refers to the classification of a stimulus as either attractive or aversive (i.e., positive or negative). An early study by Ortony et al. (1983) looked at the effects of negative emotional content on memory. They found that after participants read various positive and negative sentences, they showed better recognition for the negative sentences than for the positive sentences. Additional research has yielded similar results such as better recollection of negative stimuli after exposure to various emotional stimuli (Pratto & John, 1991; Robinson-Riegler & Winton, 1996) and that negative stimuli are remembered better over time (Kern et al. 2002). Finally, there is the significant interference that negative stimuli tend to cause, most notably demonstrated by Pratto and John (1991). Following the theory of loss aversion, they proposed that *automatic vigilance* serves as the mechanism that directs attention to negatively valenced stimuli. By observing response latency in emotional Stroop tasks (i.e. Stroop tasks consisting of positive and negative words) it was found that negative words (e.g., selfish) caused more interference on color naming than positive words (e.g., polite). Since the task only involved the identification of the color of the words, and slower response times to negative words were observed, they concluded that the negative words were being processed and that the participants' automatic attention to the negative stimuli was interfering with identifying the color of the words.

However, the emotional Stroop task has not always successfully created this effect. Wentura et al. (2000) suggested that the relevance of stimuli to the observer plays a role in what stimuli we attend to. They separated positive and negative words into *other-relevant* and *possessor-relevant* traits (i.e., positive/negative possessor relevant and positive/negative other-relevant). Possessor-relevant traits represent adjectives that are relevant to the one who possess the trait, but not necessarily to others (e.g. determined, lonely). Other-relevant traits, however, are more relevant to persons other than the possessor of the trait (e.g., considerate, violent). Using emotional Stroop tasks, they found that participant responses were slowed more by other-relevant traits than possessor-relevant traits, but response times to negative words did not differ from positive words (experiment 1 and 2).

In their third experiment, however, Wentura et al. (2000) incorporated within their procedure both approach and avoidance response types, believed to be more consistent with the natural response to affective stimuli. Namely, one would expect to avoid a negative stimulus more easily than approach it, and to approach a positive stimulus more easily than avoid it. The task was a go/no-go lexical decision task in which participants were presented with either word or non-word items and instructed to respond only to the word items. The response method differed in that the withdraw (avoidance) group held the response key down and released it when presented with a word stimulus. The touch (approach) group, in contrast, rested their finger on the response key and pressed it upon presentation of a word stimulus. The results showed an interaction between valence and response type. Specifically, they found that negative other-relevant words were more rapidly responded to in the withdraw group compared to the touch group, and positive other-relevant words were more rapidly responded to in the touch group. However, when comparing positive versus negative words, positive words were responded to faster on average. The main effect of valence can be attributed to a bias found in lexical decision tasks that favors processing of positive stimuli over negative, evidently due to differences in word frequency (van Dantzig, Pecher, and Zwaan, 2008). Although a number of studies have examined the factors that influence vigilance to negative verbal stimuli, more recent work has focused on the factors that influence vigilance to negative visual stimuli – in particular, angry faces. These factors include working memory load, mental set, perceptual load, and familiarity.

Effects of Working Memory Load on the Processing of Angry Distracter Faces

The availability of working memory resources has been shown to affect whether vigilance occurs. Van Dillen and Koole (2007) found that when there are high demands on working memory, the distracting effects of angry faces are significantly weaker. Following this finding, they showed in another study that working memory plays a role in whether or not vigilance occurs, which would imply that vigilance might not be entirely automatic (Van Dillen & Koole, 2009). In this study, participants identified the gender of happy and angry faces. In conditions in which task-load was low (e.g. retaining a 1-digit number in working memory during the gender categorization task), response times to angry faces were slower than to happy faces. However, in conditions in which task-load was high (e.g. retaining an 8-digit number), no response time differences were observed between angry and happy faces. It appears that when attentional resources are plentiful, negative stimuli are more likely to redirect attention and interfere with the primary task. However, when resources are limited, negative stimuli are less likely to interfere with task performance. This finding is inconsistent with research suggesting that high working memory load increases susceptibility to interference (Lavie, Hirst, De Fockart, & Viding, 2004). However, the results are consistent with neurological findings which indicate an emotional-cognitive interaction in the prefrontal cortex (Northoff, Heinzel, Bermpohl, Niese, Pfennig, Pascual-Leane, & Schlaug, 2004). Processing emotional information (e.g., viewing emotional photographs) is related to increases in signal strength in medial prefrontal regions and simultaneous decreases in lateral prefrontal regions. Cognitive processes (e.g., making judgments on photographs) show the opposite pattern with decreases in signal strength in medial prefrontal regions and simultaneous increases in lateral prefrontal regions. When these two processes interact, signal strength in the medial and lateral prefrontal regions fall closer to baseline. Namely, increases in cognitive activation suppress emotional activation.

Effects of Mental Set on the Processing of Angry Distracter Faces

Cues in our environment can go unnoticed when they're unrelated to our expectations. In essence, if one's expectancy, or mental set, anticipates one set of stimuli, then introducing anything outside of that set might go unnoticed (Pratt, Sekuler, & McAuliffe, 2001; White & Davies, 2008). Van Dillen, Lakens, and van den Bos (2011) showed that interference from angry faces depended on what task participants were engaged in. Participants instructed to categorize centrally presented faces as male or female were more distracted by angry faces than by happy or neutral faces, while participants instructed to categorize face color as blue or green or to categorize eye color as blue or brown did not show this difference. However, participants did display slower response times to angry faces than to happy or neutral faces when categorizing eye color if they were led to believe beforehand that eye color was associated with introversion/extraversion. Since gender and the belief that eye color is associated with personality are socially relevant details, the emotional characteristics of the faces were captured as well because they were consistent with the mental set for socially relevant details. Similarly, it has been shown that individuals high in trait anger are distracted by angry faces more than by neutral faces, while those low in trait anger show no difference between angry and neutral faces (van Honk, Tuiten, de Haan, van den Hout, & Stam, 2001). Those individuals with a mental set for anger are more distracted by angry faces than are individuals without such a mental set.

Effects of Perceptual Load on the Processing of Distracter Faces

Perceptual load studies involve procedures in which participants identify a central target stimulus among non-target stimuli while ignoring a peripheral distracter (Lavie, 1995). These tasks involve a speeded categorization of the target stimulus (e.g., left key press for the target letter "x" and right key press for the target letter "z"). In low perceptual load conditions, the target stimulus might be accompanied by a single non-target stimulus. In high perceptual load conditions, targets are accompanied by numerous non-targets, requiring more effort from the participant. For example, if the task is to identify either "x" or "z," one might encounter "xo" in a low load condition and "kdrxst" in a high load condition. Peripheral distracters can be congruent, incongruent, or neutral to the target information. When the distracter is congruent to the target (e.g. the target is "x" and the peripheral distracter is "x"), then the target tends to be categorized more rapidly compared to a neutral distracter (e.g. "d") because the attention spilling over to the distracter is aiding the categorization of the target. When the distracter is incongruent (e.g. the target is "x" and the peripheral distracter is "z"), then the target tends to be categorized more slowly compared to a neutral distracter because the incongruent distracter represents the opposite response and conflicts with categorization. However, these differences only appear to be present in low perceptual load conditions whereas in high load conditions, there are no differences in categorization times across congruent, incongruent, and neutral distracters.

Lavie (1995) suggests that there are no differences between distracter type in high load conditions because the distracters are not processed at all. High load tasks require more attentional resources leaving too few to spill over to the distracter. Low load conditions, however, leave additional resources which allow for more perceptual information to be processed, including peripheral distracters. High perceptual load can eliminate the processing of distracter objects (Lavie, Lin, Zokaei, & Thoma, 2009) and individual differences in susceptibility to distracter interference (Forster & Lavie, 2007).

A number of perceptual load studies have used socially significant distracters such as faces. Lavie, Ro, and Russel (2003) conducted such a study where participants categorized a central target name (e.g., Bill Clinton, Michael Jackson) as either a pop star or a politician while ignoring peripheral distracter faces of pop stars or politicians. Targets were identified among 1 (low perceptual load), 3 (moderate perceptual load), or 5 (high perceptual load) non-words. Relative to congruent distracter faces (e.g., Bill Clinton's face paired with the name Bill Clinton), incongruent distracter faces (e.g., Michael Jackson's face paired with the name Bill

Clinton) slowed response times in low load conditions. Contrary to prior research with verbal distracters, incongruent distracter faces also slowed response times in high load conditions. The researchers attributed this to the idea that human faces provide relevant social information that takes priority over other stimuli.

He and Chen (2010) found that familiar distracter faces could interfere in both low and high perceptual load conditions. In this study, participants had to identify the gender (male or female) of a central target name while ignoring a peripheral male or female distracter face. Targets were identified among 1 (low perceptual load), 3 (moderate perceptual load), 5 (high perceptual load), or 7 (very high perceptual load) non-words. Familiar distracters consisted of faces that were memorized by participants before completing the gender categorization task (experiments 1-3) or were pictures of well-known celebrities (experiment 4). He and Chen found that familiar distracter faces produced slower response times on incongruent trials than on congruent trials under both low load and high load. Unfamiliar faces, in contrast, produced slower response times on incongruent trials than on congruent trials only in low load. There was no difference in response times under high load. He and Chen concluded that the results from Lavie et al. (2003) could be attributed to the familiarity of politician and pop-star faces. They suggested that the salience of familiar distracter faces, rather than the social significance of faces is what draws attention in high load conditions. However, He and Chen used emotionally neutral faces in their research.

Yates, Ashwin, and Fox (2010) aimed to show that angry distracter faces could slow response times in both low and high perceptual load conditions. In addition, angry faces were split into two types where some were classically conditioned during the acquisition phase of the experiment. This phase of the study was 60 trials long, during which each face (one neutral and two angry) was viewed 20 times for 100 milliseconds each. On each trial, participants indicated whether they liked or disliked the face presented to them. For one of the two angry faces, every presentation of the face was followed by a blast of white noise (CS+) while the other angry face (CS-) and the neutral face were not. The CS+ angry face was predicted to be more salient and resistant to the effects of high perceptual load. The acquisition phase was followed by the categorization phase. Participants had to respond to a target letter, "x" or "z", embedded in either a 2 letter string (low load) or a 6 letter string (high load) presented at the center of the computer screen while ignoring a distracter face presented either above or below the letter string.

The results showed that response times were slower for CS+ angry faces than for CS- angry faces and neutral faces under low load, but there were no differences in response times under high load condition. These findings contradicted the results of He and Chen (2010) regarding familiarity. The distracter faces in Yates et al. were familiarized in the acquisition phase, yet did not yield an effect in the high perceptual load condition. However, unlike He and Chen where the distracters (male and female faces) were consistent with the mental set (male and female names), the distracters (angry and neutral faces) in Yates et al. (2010) were inconsistent with the mental set ("x" or "z"). Research reviewed earlier suggests that interference from angry distracter faces requires that the faces be consistent with one's mental set.

Erthal et al. (2005) produced results consistent with those of Yates et al. (2010). Erthal et al. created a line identification task where participants had to determine whether two peripheral lines had the same orientation while ignoring distracters in the center of the display. Distracters were either emotionally neutral pictures of people or emotionally negative photos of mutilated bodies. The line identification task had three levels of difficulty. In the easy task, intermediate task, and difficult task, the lines had a 90 degree difference, a 24 degree difference, and a 12 degree difference, respectively. In their first experiment, negative distracters slowed response times more than neutral distracters in all three difficulty levels. This implied that the images of mutilated body parts were salient enough to distract from a difficult (high perceptual load) task. However, the difference in response times for negative and neutral distracters disappeared on a very difficult task in which the line orientation difference was only 6 degrees (experiment 2). This appeared to suggest that, at some point, even especially salient distracters are not processed if the perceptual load is very high. However, as with Yates et al. (2010), the distracters were inconsistent with the mental set.

The Current Study

No study to date has examined whether familiar and unfamiliar angry and happy distracter faces are processed under conditions of high perceptual load when the faces are consistent with the mental set established by the primary task. He and

Chen (2010) showed that familiar, but not unfamiliar male and female distracter faces were processed under conditions of high perceptual load. Although the faces were consistent with the mental set established by the primary task (i.e., categorizing names as male or female), the faces were emotionally neutral. Yates et al. (2010) showed that familiar CS+ angry distracter faces were not processed under conditions of high perceptual load. However the faces were inconsistent with the mental set established by the primary task (i.e., identifying the target letter as being an "x" or a "z"). Furthermore, Yates et al. (2010) did not incorporate happy distracter faces into their study. Finally, Erthal et al. (2005) showed that unfamiliar distracter photos of mutilated body parts were not processed under conditions of high perceptual load. As in Yates et al. (2010), the photos were inconsistent with the mental set established by the primary task (i.e., comparing the orientation of lines).

The present study examined the effects of perceptual load (low, high) and familiarity (unfamiliar, familiar) on the processing of angry, happy, and neutral distracter faces. On each trial of the word-valence task, a happy or angry target word (e.g., joyful or moody) along with either 1 non-word (low perceptual load) or 5 non-words (high perceptual load) were presented. Also, a distracter face was presented to the left or right of the target word and non-words. Participants were instructed to identify whether the target word was happy or angry by pressing one of two keys and to ignore the peripheral distracter face. Thus the distracter faces were consistent with the mental set established by the word-valence task. Prior to performing the word-valence task, half of the participants were familiarized with the distracter faces and the other half were not.

Longer response times (RTs) on incongruent trials (e.g., angry face, happy word) than on congruent trials (e.g., happy face, happy word) would suggest that participants were processing the distracter faces. Neutral trials (e.g., neutral face, happy word) were used to establish whether there was differential processing of angry and happy faces. These analyses determined if angry or happy faces had any more impact on RT than neutral faces, and therefore identified whether angry or happy faces drove the difference between congruent and incongruent trials. Of interest were the effects of familiarity and perceptual load on the RT differences between congruent, neutral, and incongruent trials.

Methods

Participants

Sixty student volunteers from Morehead State University undergraduate psychology courses participated in the experiment. All participants received course credit for their participation in the experiment. Two participants were excluded from the analysis because English was not their first language and two other participants were excluded due to difficulties on the familiarization task (i.e., too many repetitions of the task). Therefore, the sample consisted of 56 participants [28 in the familiar group (6 male, 22 female) and 28 in the unfamiliar group (6 male, 22 female)] after exclusions were made.

Materials and Apparatus

The word stimuli consisted of 72 valenced stimulus words (36 happy and 36 angry) from the Affective Norms for English Words database (ANEW; Bradley & Lang, 1999). Happy and angry words differed based on pleasantness value, which can range from 1 to 9 with values below 5 reflecting negative valence and values above 5 reflecting positive valence, but did not differ on arousal, word frequency, and word length (see Appendix A and Table 1).

A total of 18 different faces were selected from the Radboud Faces database (Langner, Dotsch, Bijlstra, Wigboldus, Hawk, & van Knippenberg, 2010). There were three types of expressions (6 angry, 6 neutral, 6 happy) and for each expression, there were 3 male faces and 3 female faces. Faces were selected based on their valence scores provided by the Radboud Faces database. Valence scores are rated on a 5-point scale (negative to positive). Happy faces had the highest valence scores ($M = 4.28$), followed by neutral ($M = 3.31$), and angry ($M = 1.95$). An analysis of variance (ANOVA) indicated that valence significantly differed by face type, $F(2, 15) = 234.277, p < .001$.

The experiment was programmed using E-Prime 2.0. All stimuli were presented on a light gray background. Word and non-word stimuli were presented in black boldface 18-point Courier New font. Participants were seated so that the display was 60 cm from their face. In the low load condition, the word and non-word stimuli occupied a space in the center of the screen that was 8.5 cm wide (8.10°) and 2.5 cm high (2.39°). In the high load condition, the stimuli occupied a space that was 8.5 cm wide (8.10°) and 8.5 cm high (8.10 °). The dimensions of the photographs [width of face (not including ears) x height of face (not including neck and hair)] were 8.0 cm x 12.0 cm (7.63° x 11.42°). Finally, the edge of the central presentation area was approximately 3.0 cm (2.86°) from the edge of the face.

Word-Valence Task

The word-valence task consisted of two perceptual load conditions, one high load and one low load. In the low load condition, target words were accompanied by a single non-word while the high load condition consisted of the target word along with 5 non-words. Non-words consisted of random consonants ranging from 4 to 12 characters long ($M = 7.5$). On each trial a target word was randomly placed in 1 of the 2 (low load) or 6 (high load) positions at the center of the screen (see Figure 1). The remaining positions were filled by non-words. A distracter face appeared to the left or right of the target. The location of the face was chosen at random. Participants pressed "f" (using the left index finger) or "j" (using the right index finger) to indicate whether a word was happy or angry. The assignment of keys to word valence was counterbalanced across subjects.

Each trial began with a 500 ms fixation cross in the center of the screen that the participant was instructed to focus on (see Appendix B for the list of instructions). Next, a valenced stimulus word appeared at the center of the screen with either 1 or 5 letter-strings (depending on the load condition) and with a distracter face either on the left or right side. The stimuli were visible for 2 seconds or until a response was made, whichever came first. After the participant made a response, feedback was displayed on the screen for 2500 ms showing participants' trial RT, whether the trial was correct or incorrect, and the overall accuracy thus far in the block. If no response was made within 2 seconds, the feedback screen indicated that there was "no response" and the trial was logged as an error. After the feedback screen disappeared, the central fixation point reappeared to indicate the beginning of the next trial.

There were 2 practice blocks (1 high load and 1 low load) with 36 trials each, and 6 test blocks (3 high load and 3 low load) of 72 trials each. The faces presented in the two practice blocks were different from the faces used in the test blocks. Also, practice trials were not included in the analyses. For the 6 test blocks, participants were randomly assigned to one of two block orders (L-H-L-H-L-H or H-L-H-L-H-L). In every block, each of the 18 faces was randomly paired with two of the 36 angry words and with two of the 36 happy words. The 72 trials were presented in random order. There were 24 incongruent trials (12 angry face/happy word trials and 12 happy face/angry word trials), 24 congruent trials (12 happy face/happy word trials and 12 angry face/angry word trials), and 24 neutral trials (12 neutral face/happy word trials and 12 neutral face/angry word trials).

Familiarization Task

Participants were randomly assigned to either the familiar group or the unfamiliar group prior to the experiment. Before beginning the word-valence task, participants in the familiar group completed a familiarization task following the procedure of He and Chen (2010). The familiarization task consisted of all 18 faces that appeared in the word-valence task. The faces were presented one by one in random order at the center of the screen for 3 seconds each and participants were instructed to memorize them for the old/new recognition test that followed. The recognition test consisted of the 18 old faces in addition to 18 new faces also taken from the Radboud Faces database (Langner et al., 2010). Each face was displayed in random order at the center of the screen and remained on the screen until participants responded on the number pad with "1" for old or "2" for new. Note that none of the new faces in this recognition test were viewed during the word-valence task. Participants repeated the familiarization task until they achieved at least 90 percent accuracy on the recognition test. On average, participants required 2 repetitions of the familiarization task (*SD* = 1.362) to achieve 90 percent accuracy.

Results

For each participant, the mean reaction time (RT) of correct responses and accuracy (percentage of trials with a correct response) were calculated as a function of load (low, high), face (angry, neutral, happy), word (angry, happy), and block (1, 2, 3). The results appear in Figures 2 to 5.

Preliminary Analyses

In order to determine the effects of load, block, and word on RT and accuracy, only neutral face trials were analyzed to avoid confounds from congruency effects. Analyses of variance (ANOVAs) with load (low, high), block (1, 2, 3), and word (angry, happy) as within-subjects factors, and familiarity (familiar, unfamiliar) as a between-subjects factor were performed on the RT and accuracy data. The effect of load was significant for both RT, $F(1, 54) = 1528.56$, $MSE = 13048.20$, $p < .001$, and accuracy, $F(1, 54) = 33.20$, $MSE = 124.49$, $p < .001$, indicating that perceptual load was successfully manipulated (i.e., low load trials had shorter RTs and higher accuracy than high load trials). The effect of block was significant for both RT, $F(2, 108) = 9.34$, $MSE = 9122.50$, $p < .001$, and accuracy, $F(2, 108) = 3.54$, $MSE = 49.54$, $p = .032$. Thus there was a practice effect across blocks (i.e., participants' speed and accuracy improved from block 1 to block 3). The block x load interaction was not significant for RT, $F(2, 108) = 1.22$, $MSE = 6986.17$, $p = .300$, and marginally significant for accuracy, $F(2, 108) = 2.70$, $MSE = 40.42$, $p = .072$, indicating that the practice effect did not differ significantly between low and high load conditions. The word effect for accuracy was not significant, $F(1, 54) = 1.26$, $MSE = 47.39$, $p = .267$, however, the word effect was marginally significant for RT, $F(1, 54) = 3.19$, $MSE = 5690.94$, $p = .080$. Thus there was a tendency for participants to respond more quickly to happy words than to angry words. Finally, familiarity did not interact with any of the above effects. Thus block, load, and word effects did not differ significantly between the familiar and unfamiliar groups.

The following analyses were performed on the RT and accuracy data to determine congruency effects in the familiar and unfamiliar groups.

Familiar Group

Reaction time. ANOVAs with face (angry, happy), word (angry, happy), and block (1, 2, 3) as within-subjects factors were performed on the reaction time data in the low and high load conditions (see Figure 2). In the low load condition, there was a face x word interaction, $F(1, 27) = 8.29$, $MSE = 2326.92$, $p = .008$. Thus congruency effects were present in the low load condition [i.e., RT averaged across congruent AA (angry face, angry word) and HH (happy face, happy word) trials was shorter than that averaged across incongruent AH (angry face, happy word) and HA (happy face, angry word) trials]. Next, face effects were analyzed within each word type. Limiting the analysis to angry words, RT was shorter on AA trials than on HA trials, $F(1, 27) = 4.42$, $MSE = 2874.41$, $p = .045$. Limiting the analysis to happy words, RT on HH trials did not differ significantly from that on AH trials, $F(1, 27) = 2.06$, $MSE = 3407.39$, $p = .163$.

In the high load condition, there was a face x word interaction, $F(1, 27) = 5.14$, $MSE = 8341.80$, $p = .032$. Thus congruency effects were present in the high load condition. Limiting the analysis to angry words, RT was shorter on AA trials than on HA trials, $F(1, 27) = 11.14$, $MSE = 4937.84$, $p = .002$. Limiting the analysis to happy words, RT on HH trials did not differ significantly from that on AH trials $F(1, 27) = 0.46$, $MSE = 7381.12$, $p = .503$.

To compare low and high load conditions, load (low, high) was introduced as a within-subjects factor. The face x word x load interaction was not significant, $F(1, 27) = 0.42$, $MSE = 5595.27$, $p = .525$. Limiting the analysis to angry words, the face x load interaction was not significant, $F(1, 27) = 2.07$, $MSE = 3578.74$, $p = .161$. Limiting the analysis to happy words, the face x load interaction was not significant, $F(1, 27) = 0.07$, $MSE = 4911.57$, $p = .799$. Thus congruency effects in the high load condition did not differ significantly from that in the low load condition.

Accuracy. ANOVAs with face (angry, happy), word (angry, happy), and block (1, 2, 3) as within-subjects factors were performed on the accuracy data in the low and high load conditions (see Figure 4). In the low load condition, there was a face x word interaction, $F(1, 27) = 7.85$, $MSE = 53.30$, $p = .009$. Thus congruency effects were present in the low load condition (i.e., accuracy averaged across congruent AA and HH trials was greater than that averaged across incongruent AH and HA trials). Limiting the analysis to angry words, accuracy was greater on AA trials than on HA trials, $F(1, 27) = 5.09$, $MSE = 32.46$, $p = .032$. Limiting the analysis to happy words, accuracy was greater on HH trials than on AH trials, $F(1, 27) = 5.17$, $MSE = 50.02$, $p = .031$.

In the high load condition, the face x word interaction was not significant, $F(1, 27) = 0.16$, $MSE = 62.42$, $p = .690$. Limiting the analysis to angry words, accuracy was greater on AA trials than on HA trials, $F(1, 27) = 4.44$, $MSE = 30.19$, $p = .045$. Thus there was some evidence of a congruency effect in the high load condition. Limiting the analysis to happy words, accuracy on HH trials did not differ significantly from that on AH trials, $F(1, 27) = 0.58$, $MSE = 86.02$, $p = .452$.

To compare low and high load conditions, load (low, high) was introduced as a within-subjects factor. The face x word x load interaction was not significant, $F(1, 27) = 2.30$, $MSE = 64.78$, $p = .141$. Limiting the analysis to angry words, the face x load interaction was not significant, $F(1, 27) = 0.03$, $MSE = 31.26$, $p = .872$. Limiting the analysis to happy words, the face x load interaction was marginally significant, $F(1, 27) = 3.51$, $MSE = 76.24$, $p = .072$. Thus congruency effects in the high load condition did not differ significantly from that in the low load condition.

Unfamiliar Group

Reaction Time. ANOVAs with face (angry, happy), word (angry, happy), and block (1, 2, 3) as within-subjects factors were performed on the reaction time data in the low and high load conditions (see Figure 3). In the low load condition, there was a face x word interaction, $F(1, 27) = 18.79$, $MSE = 2202.20$, $p < .001$. Thus congruency effects were present in the low load condition. Limiting the analysis to angry words, RT was shorter on AA trials than on HA trials, $F(1, 27) = 15.99$, $MSE = 2648.18$, $p < .001$. Limiting the analysis to happy words, RT on HH trials did not differ significantly from that on AH trials, $F(1, 27) = 2.51$, $MSE = 2663.06$, $p = .124$.

In the high load condition, the face x word interaction was not significant, $F(1, 27) = 1.22$, $MSE = 11043.58$, $p = .279$. Limiting the analysis to angry words, RT on AA trials did not differ significantly from that on HA trials, $F(1, 27) < .01$, $MSE = 14231.30$, $p = .967$. Limiting the analysis to happy words, RT on HH trials showed a marginally significant difference from that on AH trials. $F(1, 27) = 3.53$, $MSE = 7167.69$, $p = .071$. Thus there was little evidence of congruency effects in the high load condition.

To compare low and high load conditions, load (low, high) was introduced as a within-subjects factor. The face x word x load interaction was not significant, $F(1, 27) = 0.60$, $MSE = 6388.16$, $p = .446$. Limiting the analysis to angry words, the face x load interaction was not significant, $F(1, 27) = 2.27$, $MSE = 8877.89$, $p = .143$. Limiting the analysis to happy words, the face x load interaction was not significant, $F(1, 27) = 0.83$, $MSE = 3605.31$, $p = .371$. Thus congruency effects in the high load condition did not differ significantly from that in the low load condition.

Accuracy. ANOVAs with face (angry, happy), word (angry, happy), and block (1, 2, 3) as within-subjects factors were performed on the accuracy data in the low and high load conditions (see Figure 5). In the low load condition, there was a face x word interaction, $F(1, 27) = 10.01$, $MSE = 49.56$, $p = .004$. Thus congruency effects were present in the low load condition. Limiting the analysis to angry words, accuracy on AA trials did not differ significantly than that on HA trials, $F(1, 27) = 1.56$, $MSE = 38.09$, $p = .222$. Limiting the analysis to happy words, accuracy was greater on HH trials than on AH trials, $F(1, 27) = 12.21$, $MSE = 46.34$, $p = .002$.

In the high load condition, the face x word interaction was marginally significant, $F(1, 27) = 3.68$, $MSE = 64.88$, $p = .066$. Limiting the analysis to angry words, accuracy was greater on AA trials than on HA trials, $F(1, 27) = 8.91$, $MSE = 81.88$, $p = .006$. Thus there was evidence of congruency effects in the high load condition. Limiting the analysis to happy words, accuracy on HH trials did not differ significantly from that on AH trials, $F(1, 27) = 0.42$, $MSE = 63.32$, $p = .523$.

To compare low and high load conditions, load (low, high) was introduced as a within-subjects factor. The face x word x load interaction was not significant, $F(1, 27) = 0.39$, $MSE = 60.33$, $p = .540$. However, the face x load interaction was marginally significant when the analysis was limited to angry words, $F(1, 27) = 2.99$, $MSE = 62.13$, $p = .095$, and significant when the analysis was limited to happy words, $F(1, 27) = 6.13$, $MSE = 68.30$, $p = .020$. Thus increased load enhanced the congruency effect associated with angry words and diminished the congruency effect associated with happy words.

Familiar versus Unfamiliar Groups

Next, analyses to determine if familiarity interacted with any of the above congruency effects were performed. The RT and accuracy analyses above were repeated with familiarity (familiar, unfamiliar) as a between-subjects factor. There were no significant interactions involving familiarity.

Neutral Face Comparisons

To determine whether RT and accuracy on angry and happy face trials differed from that on neutral face trials, a series of analyses were performed on the RT and accuracy data for neutral vs. happy and neutral vs. angry comparisons.

Reaction Time. ANOVAs with face (neutral, happy) or (neutral, angry), word (angry, happy), and block (1, 2, 3) as within-subjects factors were performed on the reaction time data in the low and high load conditions and in the familiar and unfamiliar groups. In the low load condition the face (neutral, happy) x word interaction was significant in the familiar, $F(1, 27) = 7.65$, $MSE = 21.97.\ 92$, $p = .010$, and unfamiliar, $F(1, 27) = 8.52$, $MSE = 4274.97$, $p = .007$, groups. In contrast, the face (neutral, angry) x word interaction was not significant in the familiar, $F(1, 27) = 0.05$, $MSE = 1814.51$, $p = .830$, and unfamiliar, $F(1, 27) = 0.06$, $MSE = 2535.92$, $p = .806$, groups. Thus there appears to be processing of happy faces and no processing of angry faces under low load.

Under high load, there were no significant face (neutral, happy) x word interactions in the familiar, $F(1, 27) = 0.42$, $MSE = 7317.02$, $p = .522$, or unfamiliar groups, $F(1, 27) = 0.38$, $MSE = 7565.89$, $p = .542$, and no significant face (neutral, angry) x word interactions in the familiar, $F(1, 27) = 2.52$, $MSE = 9110.24$, $p = .124$, or unfamiliar group, $F(1, 27) = 0.49$, $MSE = 7910.93$, $p = .490$.

Accuracy. ANOVAs with face (neutral, happy) or (neutral, angry), word (angry, happy) and block (1, 2, 3) as within-subjects factors were performed on the accuracy data in the low and high load conditions and in the familiar and unfamiliar groups. In the low load condition the face (neutral, happy) x word interaction was marginally significant in the familiar group, $F(1, 27) = 3.34$, $MSE = 38.73$, $p = .079$, and significant in the unfamiliar group, $F(1, 27) = 6.32$, $MSE = 31.44$, $p = .018$. The face (neutral, angry) x word interaction was marginally significant in the familiar group, $F(1, 27) = 3.58$, $MSE = 23.09$, $p = .069$, and not significant in the unfamiliar group, $F(1, 27) = 1.62$, $MSE = 41.24$, $p = .213$.

Under high load, there were no significant face (neutral, happy) x word interactions in the familiar, $F(1, 27) = 0.27$, $MSE = 61.75$, $p = .607$, or unfamiliar groups, $F(1, 27) = 2.10$, $MSE = 71.79$, $p = .159$, and no significant face (neutral, angry) x word interactions in the familiar, $F(1, 27) = 0.97$, $MSE = 54.62$, $p = .334$, or unfamiliar group, $F(1, 27) = 0.17$, $MSE = 59.85$, $p = .684$.

Discussion

Angry vs. Happy Faces

For the RT data, the face x word interactions (i.e., congruency effects) were significant in low load conditions for both the familiar and unfamiliar groups. In high load conditions, this interaction was significant for the familiar group, but not the unfamiliar group. Specifically, congruency effects were only found in high load conditions when the faces were familiar to the participants. Although the face x word x familiarity interactions were not significant for either low or high load, the absence of a congruency effect in the unfamiliar group in high load conditions was considered to be important. Namely, these findings were consistent with the results of He and Chen (2010) who showed that familiar and unfamiliar faces can be processed under low perceptual load, but that only familiar faces can be processed under high perceptual load. He and Chen, however, used only neutral faces. Thus the results of the present study extend the results of He and Chen to emotional faces.

For the accuracy data, the congruency effects were significant in low load conditions for both the familiar and unfamiliar groups. In high load conditions, the face x word interaction was not significant for the familiar group, but marginally significant for the unfamiliar group. Thus the accuracy data did not display the same familiarity effect in the high load condition as seen in the RT data. However, accuracy was significantly greater on AA trials than on HA trials in both the familiar and unfamiliar groups under high load, providing some evidence for a congruency effect. Interestingly, the accuracy data suggest that participants might have processed unfamiliar, as well as familiar faces under high load. These findings show that HA trials were more difficult than AA trials under high load conditions. This might imply that the incongruent distracter faces were interfering with the decision process, resulting in error. However, RTs for HA trials did not differ from AA trials in the unfamiliar group suggesting that the incongruent distracter faces were not interfering with the word-valence task. One possibility for this contradiction is that familiar and unfamiliar distracter faces affect accuracy differently than they do RT. It is unclear how the present study's accuracy data compares to He and Chen's (2010) research because their accuracy analyses went no further than to ensure that there were no speed-accuracy trade-offs. Therefore, additional research is required to resolve this issue.

Prior neurological research provides some interpretation as to why familiar, but not unfamiliar faces are processed under high load conditions. Previous studies have identified that familiar faces lead to greater activation in areas associated with long-term memory. For example, it has been shown that familiar faces elicit greater precuneus activation compared to unfamiliar faces (Gobbini & Haxby, 2006). This is of importance because the precuneus is also activated by tasks that require long-term memory (Burgess, Maguire, Spiers, & O'Keefe, 2001). Similarly, familiar faces are associated with increased anterior middle temporal, hippocampal, and lateral prefrontal activation (Gorno-Tempini et al., 1998; Leveroni et al., 2000; Sergent, Ohta, & MacDonald, 1992; Sugiura et al., 2001). These findings suggest that there might be spontaneous retrieval of stored information related to the familiar faces. Other neurological research has demonstrated that familiar faces are related to weaker activation in areas associated with working memory and attention. Familiar faces elicit weaker responses in the intra-parietal sulci and the middle and inferior frontal gyri, which suggests that they require less attention to process (Gobbini & Haxby, 2006). Taken together, these findings suggest that familiar faces are spontaneously retrieved from memory and are processed with limited resources, thereby accounting for the processing of familiar faces under high perceptual load.

Angry vs. Neutral Faces and Happy vs. Neutral Faces

In low load conditions, both the familiar and unfamiliar groups' neutral comparisons revealed that the RT difference between happy face trials and neutral face trials varied as a function of word valence (i.e., there was a face (neutral, happy) x word valence interaction) indicating a congruency effect. However, the RT difference between angry face trials and neutral face trials did not vary significantly as a function of word valence suggesting no congruency effect. In high load conditions, RTs for happy face versus neutral face trials and angry face versus neutral face trials did not differ as a function of word valence in the familiar and unfamiliar groups.

The accuracy data showed some similar trends to the RT data in low load conditions. Happy face trials and neutral face trials significantly varied as a function of word valence in the unfamiliar group and marginally in the familiar group. Angry face trials and neutral face trials showed a marginally significant difference as a function of word valence in the familiar group and a nonsignificant difference in the unfamiliar group. In high load conditions, neutral comparisons again revealed no differences between emotional and neutral faces in the familiar and unfamiliar groups.

The above findings suggest that happy faces were processed under low load and angry faces were not. This is in contrast to the results of Van Dillen and Koole

(2009) and Van Dillen et al. (2011) that showed that participants were slower to categorize angry faces as male or female than happy faces (i.e., angry faces were more distracting). Furthermore, the lack of a difference between angry and neutral faces is in contrast to the findings of Yates et al. (2010). They found that both unconditioned and conditioned angry faces showed longer RTs than neutral faces on a low perceptual load task. Similarly, Erthal et al. (2005) found that unpleasant photographs were more distracting than neutral faces on an easy line discrimination task. However, the current study appears to indicate that the angry faces were not being processed in low load (i.e., easy) conditions.

Some of the contrasting findings might have been due to procedural differences. Specifically, emotional faces were presented peripherally in the current study whereas Van Dillen and Koole (2009), Van Dillen et al. (2011), and Erthal et al. (2005) presented faces centrally. In addition, the tasks in Van Dillen and Koole and Van Dillen et al. involved identifying the gender of the faces which might have allowed for easier processing of emotional characteristics. Of course, Yates et al. (2010) presented faces peripherally in their study, yet angry faces were still more distracting than neutral faces. Even more interesting is that the faces were not consistent with the mental set (i.e., identifying "x" or "z"). Given that the current study controlled for mental set (i.e., happy and angry words), the expectation was that attention would more easily spill over to the happy and angry faces. As this was the case for happy faces and not angry faces, possible confounds and biases were considered to explain the inconsistencies of the current study with previous research.

A recent study by Becker, Anderson, Mortensen, Neufeld, and Neel (2011) reviewed visual search literature (i.e., a paradigm that involves participants viewing matrices of stimuli and judging whether or not there is a unique stimulus among the others) that used angry and happy faces. In the studies reviewed, participants identified discrepant happy or angry faces among neutral faces. Becker et al. (2011) elaborated on the inconsistencies in the findings of these studies and suggested that those that showed faster identification of angry faces among neutral faces compared to happy faces among neutral faces could be explained by perceptual confounds rather than their emotional characteristics. For example, in Hansen and Hansen's (1988) study, it was later revealed that the superior recognition of angry faces they found was due to a dark blotch at the base of the angry faces from the conversion of the photograph to a pixilated image. When Purcell, Stewart, and Skov (1996) performed the same study with the dark blotch removed, the advantage for recognizing angry faces disappeared.

Becker et al. (2011) suggested that faces with open mouths or exposed teeth can create similar perceptual pop-out effects. For example, angry faces with open mouths are more distracting than those with closed mouths because the open mouth creates a dark spot at the base of the face. Similarly, smiling faces with exposed teeth create noticeable white spots at the base of the face. Both the current study and Yates et al. (2010) were guilty of this confound. In Yates et al. (2010), one of the two angry faces had an open mouth which might have contributed to the bias for recognizing peripheral angry faces over neutral faces. However, no figures in Yates et al.

displayed the neutral face and no appendix was provided, so it is unclear whether or not it had an open mouth. In the current study, all smiling faces had exposed teeth while all angry and neutral faces' mouths were closed. Becker et al. (2011) ran two visual search studies using happy and angry face stimuli. In the first study, happy faces were displayed with exposed teeth while angry faces had closed mouths. In the second study, they controlled for the confound by cropping the photographs so that only the eyes and eyebrows were showing. They found that happy faces were recognized faster than angry faces in both studies with the effect being slightly moderated when the mouths were not shown. Therefore, the bias for happy faces in the current study might not entirely be attributed to the confound of exposed teeth.

Another confound addressed by Becker et al. (2011) was the reusing of the same faces repeatedly. Since genuine threatening faces are difficult to demonstrate on command, in contrast to happy faces, many studies use a small number of angry faces and repeat the same angry faces to reduce the variability of emotional expressiveness. However, participants might be responding to particular salient features of those faces rather than the emotional expression. This is another confound in which Yates et al. (2010) were guilty of because only two angry faces and one neutral face were used in their study. The current study was not guilty of this confound because multiple faces were used and familiarity was limited to only one group. Thus the bias for happy faces in the current study cannot be attributed to this confound. Plus, Becker et al. (2011) controlled for this confound in a second experiment using computer modeled schematic faces in a visual search paradigm. All faces had closed mouths, variable appearances, and variable levels of emotional expressiveness to eliminate confounds. Again, happy faces were recognized faster than angry faces. Therefore, when salient perceptual confounds are removed, happy faces appear to be superior to angry faces at capturing attention.

Recent research has uncovered more evidence of a happy, rather than angry bias for peripheral distracter faces. In particular, Faivre, Berthet, and Kouiderm (2012) showed that visual crowding appears to have adverse effects on processing peripheral angry expressions, but not happy expressions. Visual crowding involves surrounding a stimulus with flanker images or patterns which share characteristics with the stimulus and disrupt its processing, much like perceptual load tasks disrupt the processing of distracters. Faivre et al. (2012) conducted a study in which participants fixated on a cross while ignoring peripheral crowded angry and happy faces. In one group, participants were instructed to decide if a Chinese character was pleasant or unpleasant based on their intuition. In the other group, they were instructed to disagree with either the word "happiness" or "anger" based on their intuition. Their findings indicated that happy faces, despite visual crowding, were biasing the responses in both groups while angry faces were not. Furthermore, it can be guaranteed that the happy faces were processed peripherally because the participants' eye movements were monitored. Specifically, if their focus left the fixation area, the emotional face would change into a neutral face to eliminate any possibility of foveal processing.

In another experiment, Faivre et al. (2012) modified the procedure so that the visually crowded faces would appear at the fixation point allowing for foveal processing. When this was done, targets were more likely to be rated as pleasant after happy faces and more likely to be rated as unpleasant after angry faces. Therefore, both angry and happy faces were able to bias judgments when processed foveally, but only happy faces were processed peripherally. This relates to the current study in that faces were only presented peripherally and participants were instructed to ignore them. This limited the occurrence of foveal processing and thus the processing of angry distracter faces. Although peripheral angry faces were processed in Yates et al. (2010), the effect could arguably be explained by the previously mentioned confounds (e.g., open mouthed face, repeating stimuli).

The influence of foveal processing might also be relevant to the findings of Van Dillen and Koole (2009) and Van Dillen et al. (2011). As mentioned earlier, faces in these experiments were presented centrally. Therefore, both angry faces and happy face should have been sufficiently processed. However, angry faces were responded to slower than happy faces in both of these studies. The appendix of Van Dillen et al. presented only two examples (one happy face with exposed teeth and one open mouthed angry face) of their twenty faces (10 happy, 10 angry). Van Dillen and Koole, on the other hand, did not provide any sample faces. Thus, there is insufficient information to determine if the angry bias found in these studies were the result of the confound of exposed teeth/open mouth.

An alternative explanation for the findings of the current study is that happy faces were more easily processed because the procedure in which they were presented was more approach oriented. Recall that in their third experiment, Wentura et al. (2000) incorporated approach and avoidance response types within their procedure. They found that, negative other-relevant words were more readily responded to in the avoidance condition compared to the approach condition, and positive other-relevant words were more readily responded to in the approach condition compared to the avoidance condition. Based on these results, one might attribute the current study's findings to an approach bias. However, van Dantzig et al. (2008) demonstrated that the outcome of the action is more important than the action itself. In their study, participants responded with key presses to positive and negative words. After responding, the word would either appear to move toward or away from the participant. They found that responses to positive words were faster when the stimulus moved toward the participant compared to when they moved away from the participant, and responses to negative words were faster when the stimulus moved away from participant compared to when they moved toward the participant. Therefore, the act of pressing the key was neutral while the outcome of the response determined whether or not the participant was approaching or avoiding the stimulus.

In the current study, participants responded by pressing a key upon the presentation of a stimulus. Although this might appear to be an approach response in relation to Wentura et al.'s (2000) third experiment, the outcome better resembles an avoidance response because all responses were immediately followed by the removal of stimuli from the display. Based on van Dantzig et al.'s (2008) research, the positive bias observed in the current study is not thought to be the result of an approach bias.

Limitations and Future Research

In the current study, participants were instructed to fixate on the central target area while ignoring the peripheral distracter face. However, there was no way to guarantee that their focus did not shift to the distracters during the 2 second presentation period. Future research must incorporate eye-tracking technology into the current study's procedure to assure that distracter faces are not processed foveally.

The bias for happy faces over angry faces contradicts theories of vigilance for negative emotional stimuli (Kahneman & Tversky, 1984; Pratto & John, 1991). Becker et al. (2011) suggested that, since happiness was a more common expression, its detection is therefore better practiced. They also suggested that the ease of detecting exposed teeth in smiles is not merely a perceptual phenomenon. Rather, they suggest that the perceptual characteristics of the standard happy expression (which includes exposed teeth) are designed to be noticeable so that individuals with friendly intentions can easily be recognized. However, further research is needed to better understand the happy face bias. Repeating the current study with closed mouthed happy faces could elaborate on the findings of Becker et al. (2011), which suggested that happy faces are better recognized even without the confound of exposed teeth. In addition, photographs should be appropriately cropped so that only the face is exposed, eliminating any other noticeable characteristics (e.g., hair, neck).

The current study did not crop photographs in this way and it is possible that these characteristics influenced the recognition of faces.

Another direction for future research is the study of biologically rather than socially relevant stimuli. This would be more appropriate for studies seeking to demonstrate vigilance to negative emotional stimuli (i.e., life threatening) because vigilance theories are based on evolutionary principles related to survival (Pratto & John, 1991). Sakaki, Niku, and Mather (2011) demonstrated both behavioral and neurological differences between biologically and socially relevant emotional stimuli. In one experiment, a biologically emotional photograph (e.g., sexual images, appetizing food, snakes, skulls), a socially emotional photograph (e.g., smiling people, money, KKK, neo-Nazis), a neutral (non-emotional) photograph, or an asterisk (control trials) appeared at the center of the screen. Shortly after, a dot appeared in the peripheral area of the screen, and participants had to identify where it appeared. They found that trials in which biologically emotional photographs appeared were responded to slower than all other types of stimuli, regardless of their arousal level or variable appearances. Socially emotional photographs, on the other hand, did not significantly differ from neutral or control trials. Namely, participants had more difficulty disengaging from the biologically emotional photographs. A surprise memory test administered after the dot-probe paradigm showed that both biologically and socially emotional photographs were better remembered than neutral photographs. However, in another experiment, they demonstrated that socially emotional stimuli were only remembered as well as biological when participants paid full attention to the photographs, but biologically emotional stimuli were remembered better than socially emotional stimuli when attention was divided.

In their third experiment, Sakaki et al. (2011) found that both biologically and socially emotional photographs produced significant activation in the left amygdala and left medial prefrontal cortex (MPFC) in a functional magnetic resonance imaging (fMRI) analysis. Activity in the dorsal MPFC was significantly greater for socially emotional photographs compared to biological. Furthermore, amygdala activation from socially emotional photographs was correlated with dorsal MPFC activation. This is of interest because the dorsal MPFC has been associated with elaborative processing of emotional stimuli (Oschner, Knierim, Ludlow, Hanelin, Ramachandran, Glover, & Mackey, 2004). Recall that in the dot-probe study, reaction times for socially emotional photographs were no different than neutral and control trials. In particular, emotional photographs that were social in nature were not being processed automatically. In addition, socially emotional photographs were only remembered as well in memory tests as biologically emotional photographs when participants fully attended to the photographs. This suggests that socially emotional stimuli require elaborative processing, which coincides with the fMRI data.

Biologically emotional photographs, showed greater activation in the occipital gyrus than socially emotional photographs, and amygdala activation was correlated with that activity. The greater visual cortex activation for biologically emotional photographs could explain the difficulty participants had in disengaging from the stimulus in dot-probe paradigm. Importantly, the interconnectivity of the amygdala and visual cortex is linked to enhanced processing of emotional stimuli (Bradley, Sabatinelli, Lang, Fitzsimmons, King, & Desai, 2003). Therefore, the behavioral and neurological evidence suggested that biologically emotional stimuli were automatically processed while socially emotional stimuli required elaborative processing.

Taking these findings into account, it is likely that angry and happy faces are not ideal for testing vigilance theories. Specifically, emotional faces are better described as socially, rather than biologically relevant because they are not directly relevant to survival and not processed automatically (Pessoa, McKenna, Gutierrez, & Underleider, 2002). In particular, it has been demonstrated that the activation of regions such as the amygdala, fusiform gyrus, superior temporal sulcus, and ventromedial prefrontal cortex elicited by emotional faces are lost when individuals' attentional resources are exhausted. Therefore, research directed at demonstrating vigilance to negative emotional stimuli should consider using biologically relevant materials (e.g., snakes, spiders; Ohman, Flykt, Esteves, 2001).

Conclusion

The familiarity effect witnessed in He and Chen (2010) was successfully replicated in the current study. Specifically, congruency effects in high load were limited to the familiar group. However, the findings suggested that participants were processing the happy faces and not the angry faces. This was in contrast to prior research that advocates a bias for negative emotional content (Erthal et al., 2005; Van Dillen & Koole, 2009; Van Dillen et al., 2011; Yates et al., 2010). Prior angry face effects were considered to be the result of perceptual confounds (e.g., exposed mouths, repetition of the same stimuli) identified by Becker et al. (2011). They also demonstrated that happy faces were superior at capturing attention compared to angry faces when these confounds were removed. Further study of emotional face recognition should consider controlling for these confounds. Furthermore, Faivre et al. (2012) recently demonstrated that happy faces, but not angry faces are processed peripherally when crowded by other stimuli. Taken together, happy faces, rather than angry faces, appear to have more privileged processing. In addition, the subject of vigilance to negative emotional stimuli should make use of biologically rather than socially relevant materials.

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Table 1

Summary of Measures for Happy and Angry Word Lists

List	Pleasantness Value	Arousal Value	Word Frequency	Word Length
Happy	7.66 (0.63)	5.54 (1.13)	23.69 (21.4)	8.94 (2.24)
Angry	2.76 (0.69)	6.00 (0.94)	16.57 (20.7)	9.06 (1.80)

Note: Values displayed are means with standard deviations in parentheses. Between-subjects t-tests showed a significant difference for pleasantness values between the happy and angry word lists, $t(70) = 31.408, p < .001$, while showing no significant differences in arousal, word frequency, and word length.

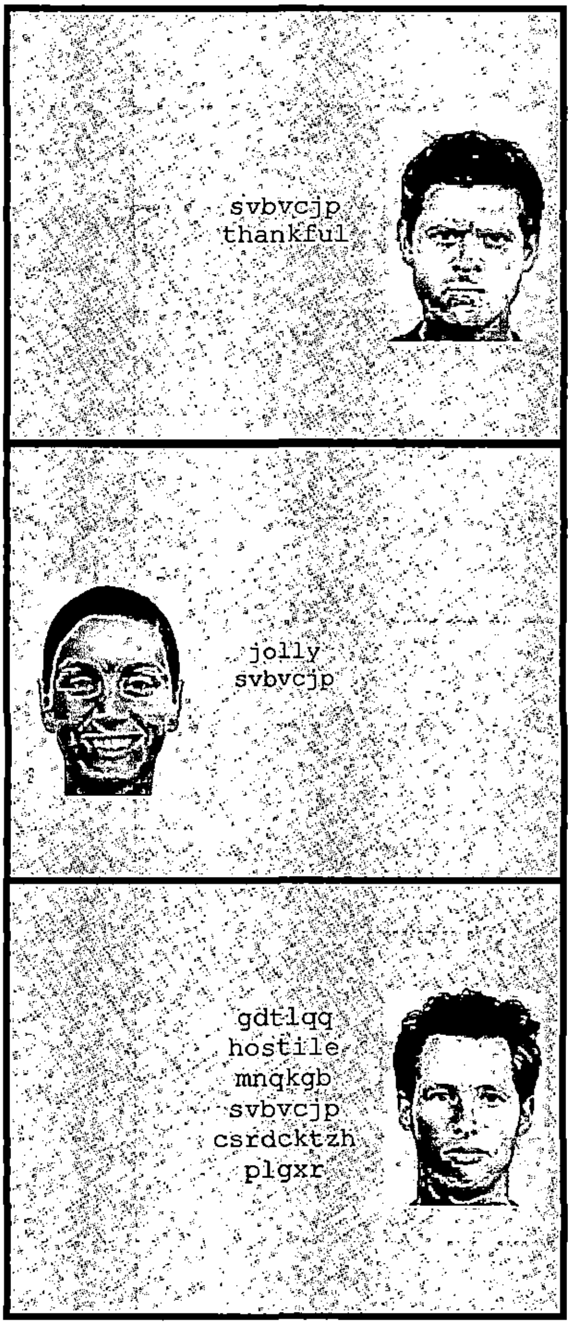


Figure 1. Example of an incongruent low perceptual load trial (top), a congruent low perceptual load trial (middle), and a neutral high perceptual load trial (bottom).

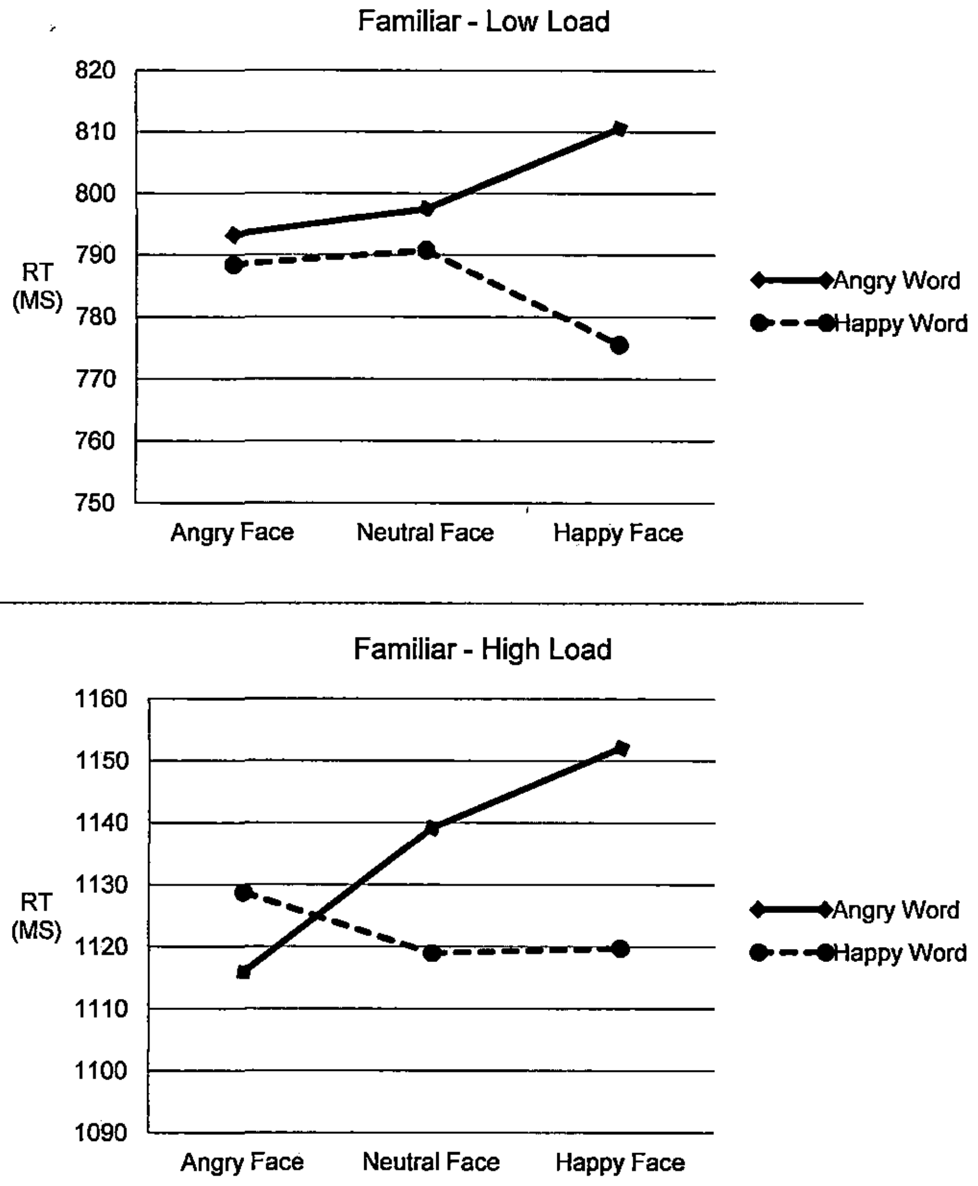


Figure 2. Mean word-valence task RTs, averaged across the 3 blocks, for low load (top) and high load (bottom) conditions in the familiar group.

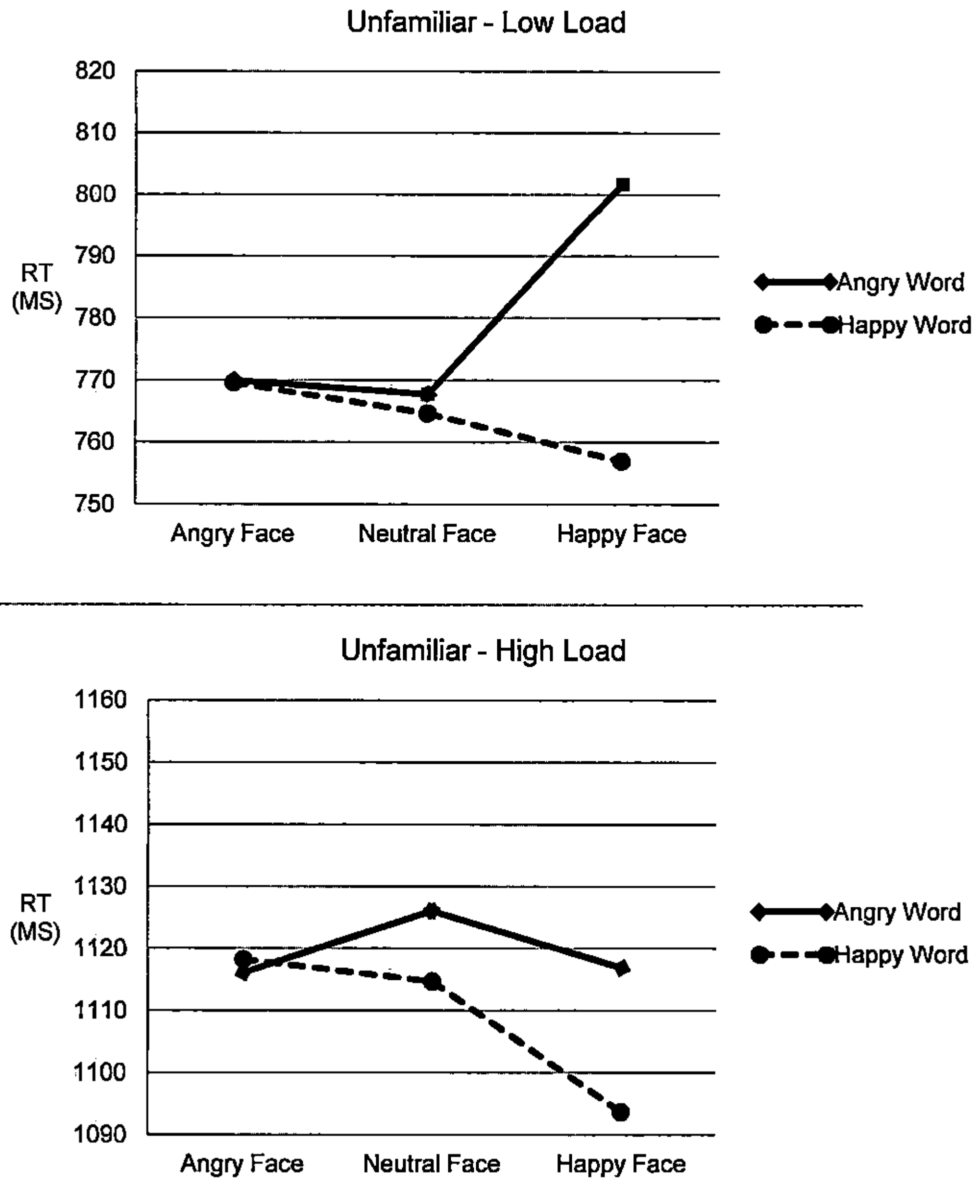
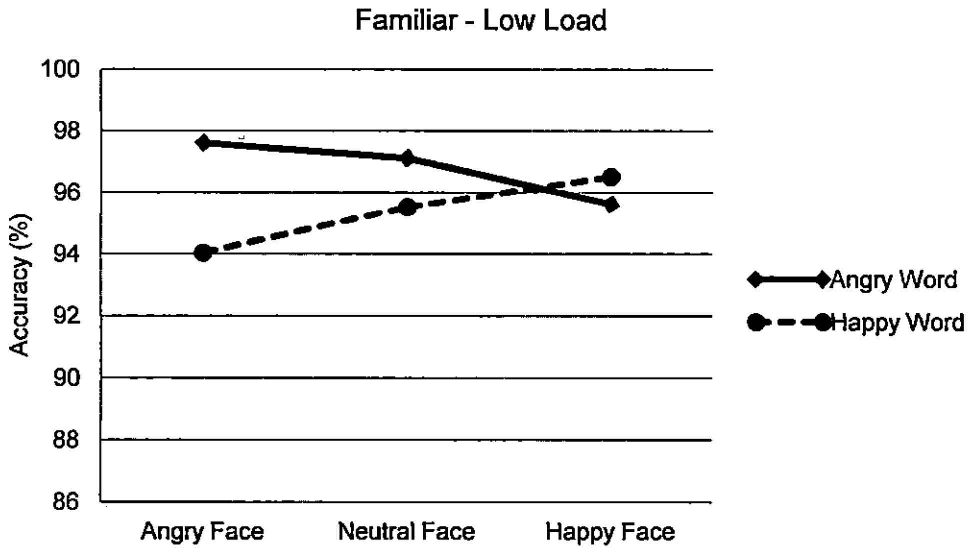


Figure 3. Mean word-valence RTs, averaged across the 3 blocks, for low load (top) and high load (bottom) conditions in the unfamiliar group.



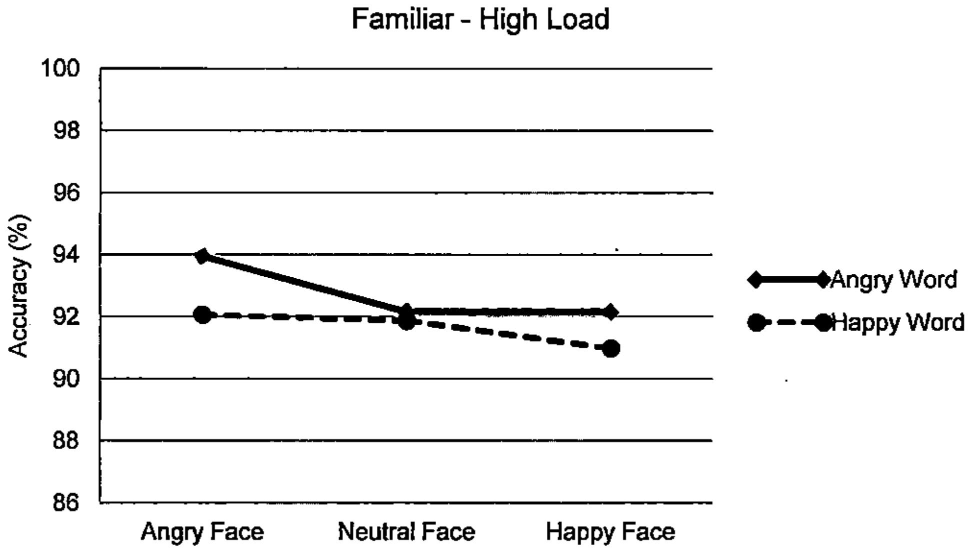


Figure 4. Mean word-valence accuracy (i.e., percent correct), averaged across the 3 blocks, for low load (top) and high load (bottom) conditions in the familiar group.

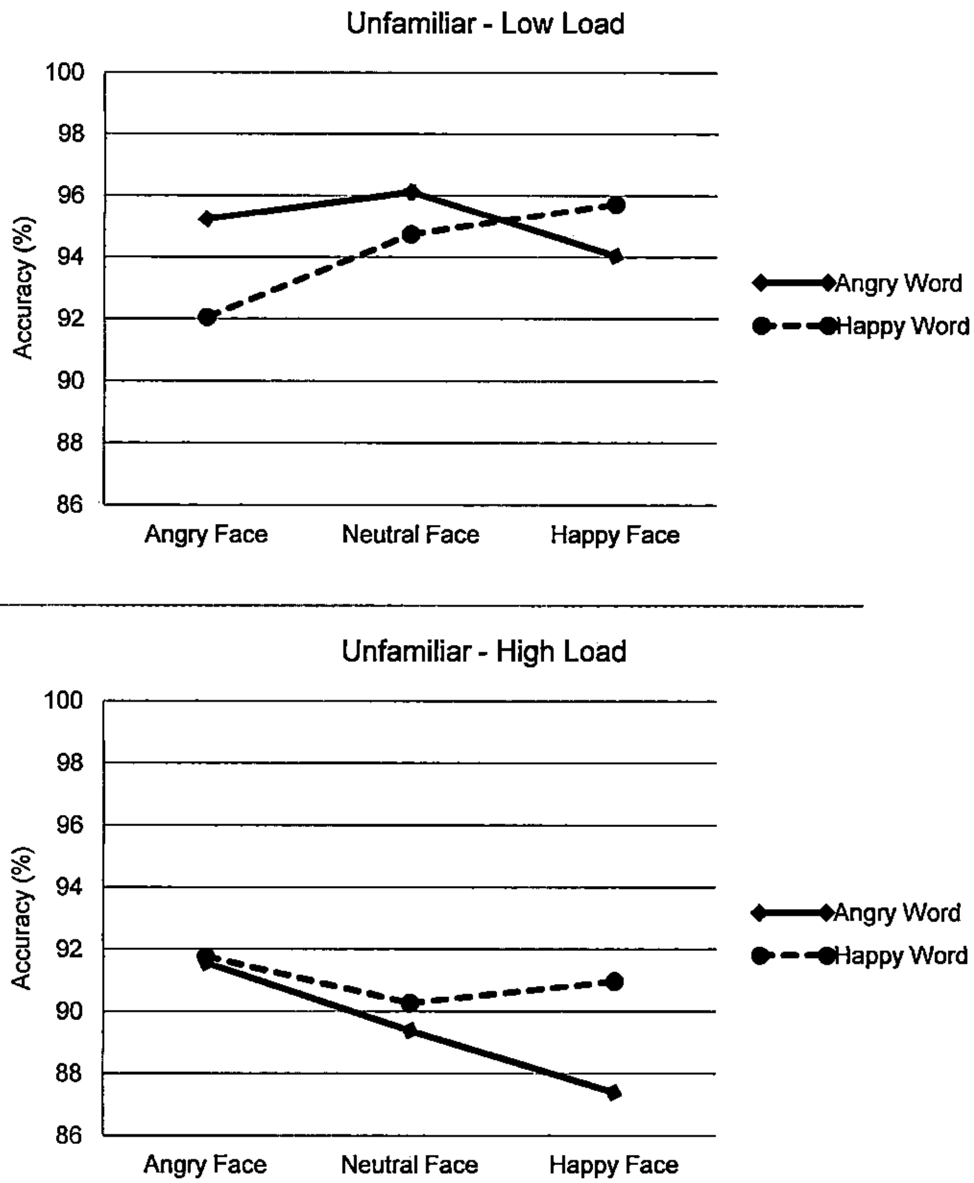


Figure 5. Mean accuracy (i.e., percent correct), averaged across the 3 blocks, for low load (top) and high load (bottom) condition in the unfamiliar group.

Appendix A

Target Stimuli Acquired from ANEW (Bradley & Lang, 1999)

Happy Words		Angry Words	
achievement	joyful	abuse	mad
bliss	laughter	aggressive	malice
carefree	lively	assault	menace
cheer	loved	brutal	moody
comedy	magical	crude	nasty
cozy	merry	cruel	offend
delight	nice	despise	outrage
ecstasy	optimism	detest	rage
elated	pleasure	disdainful	resent
enjoyment	politeness	enraged	rotten
excitement	proud	evil	rude
festive	radiant	fight	scornful
friendly	satisfied	frustrated	selfish
fun	silly	hatred	severe
grateful	terrific	hostile	terrible
humble	thankful	insult	upset
humor	thrill	irritate	violent
jolly	warmth	louse	wicked

Appendix B

Word-Valence Task Instructions as they appeared to Participants

Instructions Displayed Prior to the First Practice Block

WORD-VALENCE TASK

During this task, you will be presented with a word and non-word(s) at the center of the screen with a distracter face on either the left or right side. Some blocks of trials will have 1 non-word and others will have numerous.

Your objective is to identify the "valence" of the word. Specifically, you will be labeling the word as either "HAPPY" or "ANGRY."

While making the ANGRY/HAPPY distinction, please make your best effort to ignore the distracter faces.

After making each response, a feedback screen will display if you were correct or incorrect, as well as display your reaction time and average accuracy.

Instructions Displayed Prior to Each Low-Load Block

INSTRUCTIONS

In this block of trials, a fixation "+" will appear for a limited amount of time at the beginning of each trial.

Next, 1 WORD and 1 NON-WORD will appear at the center of the screen for 2 seconds along with a distracter image on the left or right side.

You are to identify the valence of the WORD (HAPPY/ANGRY) by pressing the appropriate key and ignoring the distracter image. Not responding within 2 seconds counts as an error.

Please make your best effort to identify the WORD as quickly and accurately as possible.

Press "f" for HAPPY
Press "j" for ANGRY

GET READY!

Appendix B (continued)

Ready your LEFT INDEX FINGER on the "f" key for HAPPY.

Ready your RIGHT INDEX FINGER on the "j" key for ANGRY.

Press the SPACEBAR when you are ready to begin.

Instructions Displayed Prior to Each High Load Block

INSTRUCTIONS

In this block of trials, a fixation "+" will appear for a limited amount of time at the beginning of each trial.

Next, 1 WORD and 5 NON-WORDS will appear at the center of the screen for 2 seconds along with a distracter image on the left or right side.

You are to identify the valence of the WORD (HAPPY/ANGRY) by pressing the appropriate key and ignoring the distracter image. Not responding within 2 seconds counts as an error.

Please make your best effort to identify the WORD as quickly and accurately as possible.

Press "f" for HAPPY
Press "j" for ANGRY

GET READY!

Ready your LEFT INDEX FINGER on the "f" key for HAPPY.

Ready your RIGHT INDEX FINGER on the "j" key for ANGRY.

Press the SPACEBAR when you are ready to begin.