TRAUMA, PTSD, AND THE PROCESSING OF EMOTIONAL INFORMATION: THE UTILITY OF EXAMINING FACIAL AFFECT RECOGNITION AND EMOTIONAL CONTEXT

BY

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DISSERTATION

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Abstract

This research is aimed at understanding emotional processing, trauma experiences, and PTSD. One of the first steps taken in this program of research was to use an underutilized method of examining emotional processing, facial affect recognition. In Study 1, I created a new stimulus set of facial expressions and contextual backgrounds, the Contextual Recognition of Affect Faces Task (CRAFT), in which participants view faces displaying different facial expressions (i.e., neutral, happiness, fear, sadness, and disgust) superimposed upon emotionally valenced (i.e., happiness, fear, sadness, and disgust) and neutral images. In the process of developing the task and using it for research with non-trauma controls, I found that context matters in facial affect recognition judgments. Individuals were generally more accurate when the emotion of the face and context matched and were less accurate when they mismatched. This research is described in Chapter 2.

I then used my task to examine the relation between PTSD symptoms factors (specifically EN) and sensitivity to emotional context in a sample of 90 individuals with trauma histories (Study 2). This research is described in detail in Chapter 3, in which I found that the facial affect recognition performance of individuals with high levels of EN was more strongly affected by emotional context than was the facial affect recognition performance of individuals with low levels of EN. I then conducted a study using eye tracking to explore one potential mechanism underlying the relation between contextual emotional processing and EN among trauma survivors (Study 3). This research is summarized in Chapter 4. After presenting the research conducted to date, I will end with a brief description of future directions for research.

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Chapter 1

General Introduction

Trauma

According to the DSM-IV (APA, 1994), a traumatic event is characterized as an event that poses a potential or actual threat of death and/or serious injury or an actual or potential threat to one's physical integrity. The individual experiencing the traumatic event often responds with feelings of helplessness, horror, and/or terror. Examples of a traumatic event include: transportation accidents, physical assault with or without a weapon, sexual assault, sudden death of someone close to you, and military and warzone exposure. Sadly enough, a large portion of individuals in the United States have experienced a traumatic event at some point in their lifetime. In large epidemiological studies, Resnick et al. (1993), Kessler et al. (1995), and Breslau (2009) found that approximately three-quarters of the population has experienced a traumatic life event. In general, men are more likely than are women to experience traumatic events (Breslau, 2009).

Post-traumatic Stress Disorder (PTSD)

Among all of the diagnoses listed in the DSM-IV (APA, 1994), Post-traumatic Stress Disorder (PTSD) is the only disorder with a specified and required cause, a preceding traumatic event. The lifetime prevalence of PTSD in the United States has been found to be approximately 10% (12.3% as reported by Resnick et al., 1993; 8% as reported by Keane et al., 2006). Numerous studies have found that women are twice as likely as men to develop PTSD (e.g.,

Breslau, 2009; Kessler et al., 1995; for a review of possible explanations see Tolin & Foa, 2006). Breslau (2009) reported that slightly less than 10% of trauma victims developed PTSD.

Researchers have found that individuals with PTSD also have high rates of comorbidity with other disorders, especially depression, substance abuse, and other anxiety disorders (Orsillo et al., 1996; Kessler et al., 1995). There are higher prevalence rates of health problems in trauma survivors with PTSD than in trauma survivors without PTSD (Schnurr & Green, 2004). Additionally, PTSD has been found to result in economic cost (e.g., work days lost) and poor quality of life (Foa, Hembree & Rothbaum, 2007). Therefore, in addition to causing debilitating psychological distress to the sufferers, PTSD also has strong negative implications for public health and the economy (Foa et al., 2007). Studies have found that if PTSD persists for a year after trauma exposure it is very unlikely to remit without psychological intervention/treatment (Kessler et al., 1995).

While exposure to a traumatic event is necessary to be diagnosed with PTSD, it is not sufficient. The traumatic event must meet specific criteria and the individual must experience a specified combination of symptoms to be diagnosed with PTSD. As described above, the traumatic event must: (1) pose a potential or actual threat of death, serious injury, or threat to one's physical integrity; and (2) evoke feelings of helplessness, horror, and/or terror. Additionally, according to the DSM-IV-TR (APA, 1994), there are 17 symptoms that individuals with PTSD can experience: (1) intrusive memories; (2) nightmares; (3) flashbacks; (4) cue distress; (5) cue reactivity; (6) avoid thoughts/feelings; (7) avoid people/places; (8) restricted affect; (9) diminished interest; (10) detachment; (11) foreshortened future; (12) amnesia; (13) disturbed sleep; (14) anger outbursts; (15) poor concentration; (16) hypervigilance; and (17) exaggerated startle. PTSD itself is generally believed to be composed of several symptom

clusters or factors which reflect underlying dimensions of the disorder. The DSM-IV (APA, 1994) divides the symptoms into three clusters: re-experiencing, avoidance and numbing, and hyperarousal. An individual must report one re-experiencing symptom (symptoms 1-5 above), three avoidance and numbing symptoms (symptoms 6-12 above), and two hyperarousal symptoms (symptoms 13-17 above).

The DSM-IV three-cluster PTSD symptom structure (i.e., re-experiencing, avoidance and numbing, and hyperarousal) has received very little empirical support. As reviewed by Palmieri, Weathers, Difede, and King (2007b), one of the most viable accounts of PTSD symptom factors parses symptoms into a four-factor model: reexperiencing, avoidance, hyperarousal, and emotional numbing (EN). This four-factor model has been supported by research by DuHamel et al. (2004), King, Leskin, King, and Weathers (1998), McWilliams, Cox, and Asmundsen (2005), Palmieri and Fitzgerald (2005), and Palmieri, Marshall, and Schell (2007a).

Emotional Numbing (EN)

Emotional Numbing (EN), a restricted range of affect, is the cardinal symptom of the EN factor described above. EN has been found to be related to a decrease in resiliency resources for individuals with trauma exposure (Johnson, Palimieri, Jackson, & Hobfoll, 2007) and to be closely associated with interpersonal impairment in individuals with war-zone related PTSD (Ruscio, Weathers, King, & King, 2002), suggesting that further research on EN is warranted. Although the majority of research and theoretical papers involving trauma have focused on PTSD as a whole and not individual symptoms, multiple researchers have proposed hypotheses to account for EN. For example, Keane et al. (1985) proposed that EN is avoidance behavior protecting an individual from re-experiencing any pain associated with the trauma. Additionally,

Litz et al. (1997) posited that EN results when an individual's attention is over-taxed and exhausted due to hyperarousal that results post-trauma. Furthermore, Milanak and Berenbaum (2009) theorized that EN is associated with disturbances in emotion regulation processes rather than simply disturbances in emotional responsivity.

Numerous researchers have examined how PTSD is associated with disturbances in emotional processing. Drawing on the work of Rachman (1980, 2001), we define emotional processing as converting an emotional stimulus (e.g., a face, a picture, a word) into something meaningful - something that can be made sense of and used. Emotional processing also encompasses the impact of emotional information on how the stimulus is interpreted, understood, recognized, and or stored as a memory, as well as the impact of the emotional stimulus on future behaviour. Investigators have consistently found that individuals with PTSD differ from controls in their processing of emotionally valenced stimuli. Using modified versions of the emotional Stroop task, researchers have generally found that individuals with PTSD respond differentially to threat words associated specifically with the type of trauma they experienced (e.g., words such as crash or highway for individuals who develop PTSD following motor vehicle accidents), but do not respond differentially to other threat, positive, or neutral words (e.g., McNally, English, & Lipke, 1998; Thrahser & Dalgleish, 1994). In contrast to the extensive research on PTSD as a whole, to our knowledge, only a single study, Milanak and Berenbaum (2009), has specifically examined the relation between emotional processing and EN (in fact, this is the only study to examine the relation between emotional processing and any specific PTSD symptom factor). Using a word naming priming task, Milanak and Berenbaum (2009) found that EN was associated with the degree to which participants took advantage of valence information to accelerate the processing of subsequently presented similarly valenced

stimuli. The results of Milanak and Berenbaum (2009) suggest that differences in emotional processing between individuals with low vs. high levels of EN are most evident when examining how exposure to one emotional stimulus influences the processing of other emotional stimuli. In other words, we did not find a main effect for EN, nor an EN x target emotional stimulus interaction. Rather we found an EN x non-target emotional stimulus interaction showing that the non-target emotional stimulus influenced how people process the target emotional stimulus. These findings are what led Milanak and Berenbaum (2009) to posit that EN is associated with disturbances in emotion regulation processes rather than simply disturbances in emotional responsivity (as indexed by responses to emotional stimuli presented in isolation).

Facial Affect Recognition

A potentially fruitful approach to studying EN and the processing of emotional information is to use paradigms from other areas of psychology and psychopathology. In fact, based on the evidence suggesting that typical emotional images influence information processing more strongly than do typical emotional words (Beall & Herbert, 2008; DeHouwer & Hermans, 1994), several psychopathology researchers (Gotlib, Krasnoperova, Yue, & Joormann, 2004; Mogg & Bradley, 2005) have recommended using images (and often faces) rather than words.

One way of studying how individuals are affected by non-target emotional stimuli when responding to target emotional stimuli is to take advantage of previous research documenting that accuracy judging facial expressions of emotion tends to be enhanced when the faces are presented in an emotion-matching context, and tends to be diminished when the faces are presented in an emotion-mismatching context (Leppanen & Hietenan, 2003; Righart & DeGelder, 2008). A wide variety of contextual cues, such as odors, pictures, and stories, have

been found to influence the judgments participants make regarding the emotion being experienced by another person (Kim et al., 2004; Carroll & Russell, 1996; Goodenough and Tinker, 1931; Munn, 1940; Fernberger, 1928; Landis, 1929). However, as discussed in detail in Chapter 2, further research concerning the effect of context on facial affect recognition is warranted.

Overview

Over the past several years, I have been conducting research aimed at understanding emotional processing, trauma experiences, and PTSD. One of the first steps taken in this program of research was to use an underutilized method of examining emotional processing, facial affect recognition. In Study 1, I created a new stimulus set of facial expressions and contextual backgrounds, the Contextual Recognition of Affect Faces Task (CRAFT), in which participants view faces displaying different facial expressions (i.e., neutral, happiness, fear, sadness, and disgust) superimposed upon emotionally valenced (i.e., happiness, fear, sadness, and disgust) and neutral images. In the process of developing the task and using it for research with non-trauma controls, I found that context matters in facial affect recognition judgments. Individuals were generally more accurate when the emotion of the face and context matched and were less accurate when they mismatched. This research is described in Chapter 2.

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with low levels of EN. I then conducted a study using eye tracking to explore one potential mechanism underlying the relation between contextual emotional processing and EN among trauma survivors (Study 3). This research is summarized in Chapter 4. After presenting the research conducted to date, I will end with a brief description of future directions for research.

Chapter 2

Study 1: The Effects of Context on Facial Affect Recognition

Facial expressions play a critical role in non-verbal communication. Systematic research examining facial affect recognition dating back to Darwin (1872) has found that significant deficits and/or biases in affect recognition are common among populations suffering from psychological and medical disorders (e.g., Bozikas, Kosmidis, Anezoulaki, Giannakou, & Karavatos, 2004; Felmingham, Bryant & Gordon, 2003; McClure, Pope, Hoberman, Pine, & Leibenluft, 2003), and such deficits and biases can have a negative effect on interpersonal interactions and safety (e.g., Fridlund, 1994; Hofmann, Suvak, & Litz, 2006; Nachson, 1995).

The majority of previous facial affect recognition research has used pictures of faces displayed on a blank background (e.g., Ekman & Frisen, 1975). This research has provided critical information regarding which aspects of facial musculature are important for making facial affect recognition judgments (e.g., Ekman & Friesen, 1975; Sullivan, Ruffman & Hutton, 2007). However, in real life, facial expressions are exhibited in context. In other words, whenever an individual is interacting with someone else and making facial affect recognition judgments, they not only perceive the face but also the context in which the "face" is located.

Imagine the following three scenarios. In one scenario, all you see is Sara's face. In the second, you see Sara's face and you can tell she is at a funeral home. In the third, you see Sara's face and she is on the Olympic medal podium receiving a gold medal. One can ask two different questions about Sara: (a) what facial expression of emotion is she exhibiting – for example, does her face look sad, happy, or neutral; and (b) what is she feeling – for example, is she feeling sad, happy, or neutral. Although one would expect that the judgment of her facial

expression would influence the judgment of what she is feeling, the two are not always identical – for example, some gold medal winners who feel very happy are crying and appear to have sad facial expressions while standing on the podium, and some mourners who feel very sad appear to have neutral facial expressions. From both personal experience and the results of carefully conducted research (e.g., Kim et al., 2004; Carroll & Russell, 1996; Goodenough and Tinker, 1931; Munn, 1940; Fernberger, 1928; Landis, 1929), we know that judgments of what people are feeling are influenced by context. Fernandez –Dols (1999) has clearly articulated how emotional facial expressions are not always direct windows into what someone is feeling, how what is on the face is not always what the person is feeling, and how context can affect judgments of facial expressions. When we see Sara at the funeral home we judge her to be feeling sad even though her facial expression is neutral; when we see Sara on the Olympic medal podium we judge her to be feeling happy even if her face suggests she is sad.

The present research explored the impact of context on facial affect recognition. Context can be defined as any information available to the decoder at the time of their judgment, other than the facial musculature, that can influence their judgment. Context information: (a) can be gleaned by all of the senses (e.g., visual, auditory, olfactory); (b) can, but need not, be directly relevant to the situation or judgment; (c) can be information presented immediately preceding or concurrently with the face, or can be information the judge has long known about the person whose face is being judged; and (d) can be an isolated bit of information (e.g., an image of a gold medal presented in isolation).

A wide variety of contextual cues, such as odors, pictures, and stories, have been found to influence the judgments participants make regarding the emotion being experienced by another person (Kim et al., 2004; Carroll & Russell, 1996; Goodenough and Tinker, 1931; Munn, 1940;

Fernberger, 1928; Landis, 1929). For example, Munn (1940) showed participants faces that were either presented in the surrounding context in which the photographs were initially taken or the identical faces presented in isolation (e.g., a photograph of a smiling person waterskiing vs. the smiling face in isolation) and asked participants what emotion the person was experiencing. Along the same lines, Carroll and Russell (1996) had participants read stories, then showed them a picture of a face, and then asked participants "what emotion is the woman [man] feeling" (p. 209). In all of these studies, the investigators instructed the participant to make a judgment about what emotion the person in the picture was experiencing and did not ask the participant to make a judgment about the face. An implicit assumption made by researchers such as Carroll and Russell (1996) is that the informational value attached to the face is not itself affected by the additional contextual information being presented, and that respondents simply weigh the two pieces of independent information (i.e., the face and the context) when judging what emotion the person is experiencing.

In contrast, in the present study, rather than asking what emotion the person was feeling, we asked participants to indicate what the face was showing. Would the judgment of what facial expression is being exhibited be influenced by context as well, or are these judgments influenced only by facial musculature? The goal of Study 1 was to explore this question, which has received relatively little attention, and is different from the question of whether context influences judgments of what someone is feeling. The question of whether context influences judgments of facial expressions is important in part because facial expressions influence judgments of what people are feeling. It is possible that context influences judgments of what people are feeling in two different ways: (a) directly, by influencing the judgment of what the person is feeling; and (b) indirectly, by influencing the judgment of what is on the face.

To our knowledge, only three previous studies have examined how context influences the judgment of what is on the face (as opposed to the many studies examining how context influences the judgment of what the person is feeling). Leppanen and Hietanen (2003) directly examined whether the judgment of the face itself is influenced by context (participants were instructed to "identify which of the two emotions was presented on the screen"), using odors as the context. In their design, two experiments examined how odors affect facial affect recognition judgments of neutral, happy and disgust emotional facial expressions. Leppanen and Hietanen (2003) found that participants: (a) more accurately and quickly identified happy facial expressions when presented along with pleasant odors than when presented along with unpleasant odors; and (b) more accurately identified disgust facial expressions when presented along with unpleasant odors than when presented along with pleasant odors, though the odors did not affect the latency of identifying disgust expressions.

Righart and de Gelder (2008a) also examined how context affects the recognition of facial expressions. Participants viewed images composed of faces superimposed on a scene and were asked to categorize faces as fearful, disgusted, or happy. They found that participants had higher accuracy rates and faster reaction times when the emotion of the face and surrounding context were congruent. Thus, while similar, the results of the studies by Leppanen and Hietanen (2003) and Righart and de Gelder (2008a) were not entirely consistent. Specifically, whereas Leppanen and Heitanen (2003) found that the context did not affect reaction time for identifying disgust facial expressions, Righart and DeGelder (2008a) did. The role of context was also examined by Righart and de Gelder (2008b), who examined only happy and fearful expressions superimposed on happy, fearful, and neutral backgrounds. They found that individuals viewing happy faces were faster at recognizing happy faces when they were

presented in happy and neutral scenes than when presented on fearful scenes; response times were similar for happy faces on happy vs. neutral backgrounds. Although responses to fear faces on fearful backgrounds were faster than fear faces on happy and neutral backgrounds, the differences were not statistically significant. The effect of context on accuracy was not examined due to ceiling effects.

The present research was needed for a variety of reasons. First, the results of the three previous studies were not entirely consistent. Second, the sample sizes in the previous studies were small (Leppanen & Heitanen: n=20 and n=45; Righart & DeGelder (2008a): n=22 and n=15; Righart & DeGelder (2008b): n=18), which might help explain why the results were not entirely consistent. Third, neither of the previous studies had examined sad expressions. Not only is it important to examine sadness for its own sake, but also by including multiple negative emotions, including sadness, we were able to test whether contextual effects are emotion specific or valence specific. Fourth, the previous studies examined only high intensity facial expressions. By choosing emotional facial expressions that are not at extreme levels of intensity, we were able to examine recognition patterns that are more like those in everyday interactions, and we were also able to avoid potential ceiling effects from very easy recognition, which was the case in Righart and deGelder (2008b); and (5) the previous studies explicitly directed participants' attention to the context -- by not explicitly directing participants' attention to the context we were able to examine processing which is closer to how daily facial affect recognition judgments are probably made.

A second, related, goal of the present research was to develop a task for measuring nonverbal emotional processing that could be used by researchers in a variety of settings and studying a variety of populations. The task used by Leppanen and Hietanen (2003) used odors as

context, which are not emotion-specific and are more complicated to use than visual images presented on a computer monitor. The task used by Righart and DeGelder (2008a and 2008b) did not include sad expressions or sad context, used facial expressions of high intensity which could lead to ceiling effects, and used faces that were not racially diverse. Thus, we developed a task that addressed all of these issues.

To summarize, we developed a novel task that enabled us to test the hypothesis that individuals' judgments concerning facial expressions (what is on the face), as well as how quickly those judgments are made are influenced not only by the facial expression but also by context. We hypothesized that participants would have: (1) higher accuracy rates and faster reaction times when the emotion of the face matches the emotion of the context; and (2) lower accuracy rates and slower reaction times when the emotion of the face mismatches the emotion of the context.

Method

Participants

Participants were 321 university students (60% female) ranging in age from 18 to 23 (M = 19.0, SD = 1.0). The ethnic composition of the sample was as follows: 64.3% European American/White, 8.3% African American/Black, 12.6% Asian American, 8.3% Latino/a, 4.3% Bi-racial, and 2.1% non-disclosing. Participants received course credit in return for participating.

Procedure

In a single session, participants completed the facial affect recognition task described below and a series of questionnaires (not examined in the present paper).

Facial Affect Recognition was measured using the Contextual Recognition of Affective Faces Task (CRAFT), developed for this research, in which participants view faces displaying different facial expressions (i.e., neutral, happiness, fear, sadness, and disgust) superimposed upon emotionally valenced (i.e., happiness, fear, sadness, and disgust) and neutral images.

The context images upon which the facial expressions were superimposed were selected following pilot testing in which participants (n=73) made two types of ratings of images (n=104) selected from the International Affective Picture System (IAPS; Lang, Bradley, and Cuthbert, 1999) and selected from publicly available online images. Each image was rated on a 1 to 5 Likert Scale for each of the 6 emotions, as well as neutral. Participants read the following instructions on the computer screen: "You will be shown 104 images. Each will appear briefly for about 2 seconds. After they disappear you will be asked to rate how much each expresses anger, sadness, disgust, fear, happiness, surprise, or is neutral on a scale from 1 to 5 with "1" meaning no emotion and 5 meaning extreme emotion." In addition, pilot participants made a forced choice rating for each image – instructions were: "After you rate each individual emotion, you will then be asked to choose which category best describes the image (whether it best expresses anger, sadness, disgust, fear, happiness, surprise, or is neutral)." To be included in the final version of the CRAFT, an image had to receive an average rating of at least 3.5 (1 = absent; 5 = extreme) on the corresponding emotion, and at least 60% of participants correctly identified the emotion in a forced choice task. Eight context images for each of four emotions (happy, sad, fear, and disgust) plus 24 neutral context images met the inclusion criteria and were chosen for the CRAFT. Examples of context images included in the CRAFT are: a hand holding a gun, a shark, a tornado scene (fear); a beach, cute puppies, fireworks (happy); bugs on food, a dismantled arm, a bloody scene (disgust); a casket, a cemetery, a funeral procession (sadness); a

coat rack, a filing cabinet, a desk lamp (neutral). Averaging across the images, happy images were rated happy 83.5% of the time, disgust images were rated disgust 78.4%, sad images were rated sad 83.5%, fear images were rated fear 67%, and neutral images were rated neutral 93%.

Although anger and surprise context images were included in the pilot testing, anger and surprise images were not included in the CRAFT task because none of the images met the inclusion criteria. We were unable to find context images that were considered representative of anger (and not other emotions) that did not also include in them other facial expressions of emotion that confused participants as to which face they were to judge. Surprise was not included because we were unable to find context images that were considered representative of surprise and not other emotions, most likely because surprise typically "merges into fear, amusement, relief, anger, disgust" (Ekman, 2003, p. 148).

The facial expressions were selected from among faces used in other research in our lab. For our previous research, facial expressions were created by preparing six base faces varying on gender and ethnicity (e.g., Sub-Saharan African male, East Asian female) with Poser 6 (SmithMicro), and then morphing each face to create facial expressions of emotion. Each emotional expression was then morphed to adjust intensity levels (e.g., the group of muscles that move to create a smile – action unit 12 – was increased in magnitude for happy expressions). Finally, each expression was varied on five levels of intensity of emotion. An expression was set at 100% intensity and then adjusted to represent 20, 40, 60 and 80% of that expression to give five levels of intensity.

For this specific task, we chose a subset of the faces. Given the extensive research showing that some emotions are more easily recognized than others (e.g., Hess, Blairy, & Kleck, 1997; Spencer-Smith et al., 2001), we took steps to reduce differences in recognition difficulty

across emotions; specifically, we selected the following levels of intensity for each emotion: disgust 80% and 100%; fear 60% and 80%; sad 40% and 50%; happy 30% and 50%. Although the accuracy rates across emotions were not perfectly matched, we chose the two intensities for each emotion that would prevent floor and ceiling effects (such as the ceiling effects found by Righart and deGelder, 2008b). Please see Figure 2.1 for examples of these faces. Thus, for each emotion (happy, sad, fear, disgust) there were 12 faces [2 (male/female) x 3 (Sub-Saharan African/East Asian/European) x 2 (level of intensity)], and there were 6 neutral faces [2 (male/female) x 3 (Sub-Saharan African/East Asian/European)]; thus there were 54 different face images. To verify that the facial expressions of emotion were recognizable, four undergraduate students were asked to indicate for each of the eight emotional facial expressions (i.e., two sad, two fear, two disgust, two happy) which two were sad, which two were fearful, and so on; this sorting task was completed six times, once for each face type (e.g., male African, female European). Three of the four students correctly sorted every single face, and the fourth student made two errors; thus sorting accuracy was 98.6 percent across the four students.

Disgust 80%	Disgust 100%
	

Figure 2.1. Examples of facial expressions used in the CRAFT

Fear 60%	Fear 80%
	
Happy 30%	Happy 50%
	
Sad 40%	Sad50%
	

Figure 2.1 (cont.). Examples of facial expressions used in the CRAFT

The CRAFT is composed of 168 trials (each of the 54 face images was presented three times – once paired with a neutral background image, once paired with the matching emotion

context image, and once paired with a mismatching emotion context image). The order in which the 168 trials were administered was randomized separately for each participant. On each trial, the participant is presented with a single face image superimposed upon a single emotionally valenced or neutral image. All context images covered the entire computer monitor; the size of the face superimposed upon the context image was identical in all trials. Participants responded using a keyboard that had five keys labeled with the following emotions: "happy," "sad," "fear," "disgust," and "neutral." Participants had to select, by pressing one of the five labeled keyboard keys (using the index finger of their dominant hand), which of the aforementioned labels most accurately described the emotional expression on the face. They read the following instructions on the screen: "You will be seeing 168 sets of images. Each image is made up of a background picture and a picture of a face. The faces will appear in different locations on the screen. Your task is to decide which of the five emotional expressions is being shown by the face."

Participants were given practice trials to learn the position of the answer keys (the emotion words) on the keyboard. There were six different orders that the emotions appeared to reduce order effects. For example, one participant may have the far left keyboard key represent the emotion fear, whereas another participant's far left keyboard key was for the response happy. Once all of the practice trials were completed, they were given the instructions "Please choose which emotion best describes the facial expression." Both accuracy and response latency were measured. Following Kerns and Berenbaum (2000), reaction times shorter than 300 ms were eliminated. RTs were also removed from analyses if they were: (1) smaller than or larger than 3 standard deviations of the group grand mean; and/or (2) smaller than or larger than 3 standard deviations of the individual participant's mean. Finally, a log linear transformation was used on the RT data to correct for skewness/kurtosis.

There were 3 context conditions: matching (both face and image are the same emotion), mismatching (face and image are different emotions), and neutral (emotional face on a neutral image). Figure 2.2 shows examples of each context condition. Each type of emotional facial expression (happy, sad, fear and disgust) was presented 36 times (12 times in the matching condition, 12 mismatching, and 12 neutral), and neutral facial expressions were presented 24 times (12 matching and 12 mismatching). For example, for fear facial expressions: (a) 12 fear faces on fear images were presented; (b) 12 fear faces on mismatching contexts (4 on happy contexts, 4 on sad contexts, and 4 on disgust contexts) were presented; and (c) 12 fear faces on neutral contexts were presented. Images were displayed on the screen until the participant made a response. As soon as the participant made a response, the next face superimposed on an image would appear. There were multiple positions where the face could be located (top or bottom left, top or bottom right, or center). Multiple positions were used so that the participant would have to scan each image. Had the face always been placed in the same position, participants might have used a strategy of focusing exclusively on the face (whose location they would have easily learned) and ignoring the background context information – such a strategy was preempted by moving the position of the face around across trials. The locations of the faces were counterbalanced to make sure that each emotional expression was not more likely to be in one location (e.g., the right) than another (e.g., the left).

Matching Context: Fear Face on Fear Context Image	
Mismatching Context: Happy Face on Fear Context Image	
Neutral Context: Sad Face on Neutral Context Image	

Figure 2.2. Examples of face/context image pairings used in the CRAFT

Results

As expected, the facial expressions tended to be recognized correctly. Specifically, for neutral backgrounds, happy expressions were recognized 63 percent of the time, sad expressions 64 percent of the time, fear expressions 72 percent of the time, and disgust expressions 57 percent of the time. Averaging across context conditions, the happy expressions were recognized 63 percent of the time, sad expressions 65 percent of the time, fear expressions 75 percent of the time, and disgust expressions 60 percent of the time. Thus, we were reasonably successful in our attempts to minimize accuracy differences across emotions and to prevent floor and ceiling effects. Please see Table 2.1 to see a breakdown of accuracy for each emotional expression across each emotional context.

Table 2.1. Proportion accuracy for each emotional facial expression for each emotional context

		FACE			
		Fear	Disgust	Happy	Sad
Context	Fear	.83	.57	.58	.58
	Disgust	.67	.70	.65	.59
	Happy	.68	.53	.63	.57
	Sad	.73	.50	.67	.72

To examine the impact of context on accuracy, we conducted a 3 (Context Condition: match vs. mismatch[1] vs. neutral) x 4 (Emotion on the face: happy vs. sad vs. fear vs. disgust) repeated measures ANOVA. There were significant effects for both context, F (2, 319) =78.58, p <.01, eta^2=.33, and emotion on the face, F (3, 318) =77.83, p <.01, eta^2=.42. In addition, there was a significant context x emotion on the face interaction, F (6, 315) =47.50, p <.01, eta^2=.48. As can be seen in Figure 2.3, participants tended to be most accurate when the context and face matched on emotion and least accurate when context and face were mismatched on emotion. Separate post-hoc contrasts (paired t-tests) were conducted for each emotion (i.e., happy, sad, fear, and disgust) comparing matching vs. mismatching, matching vs. neutral, and mismatching vs. neutral accuracy rates. Given the 9 contrasts conducted, we used a Bonferroni correction to cut the alpha, resulting in an alpha of $p < .006$. For sad, fear and disgust, all contrasts had a $p <$ .0001 except for the disgust mismatch vs. neutral contrast ($p = .008$). In contrast, as can be seen in Figure 2.3, accuracy for happy faces was not influenced by context. Happy contrasts were examined separately, and $p > .9$ for all comparisons.

[1] The mismatch score was calculated by averaging across all of the different mismatching emotional contexts (e.g., for a sad facial expression, mismatching emotional contexts would be happy, fear, and disgust expressions).

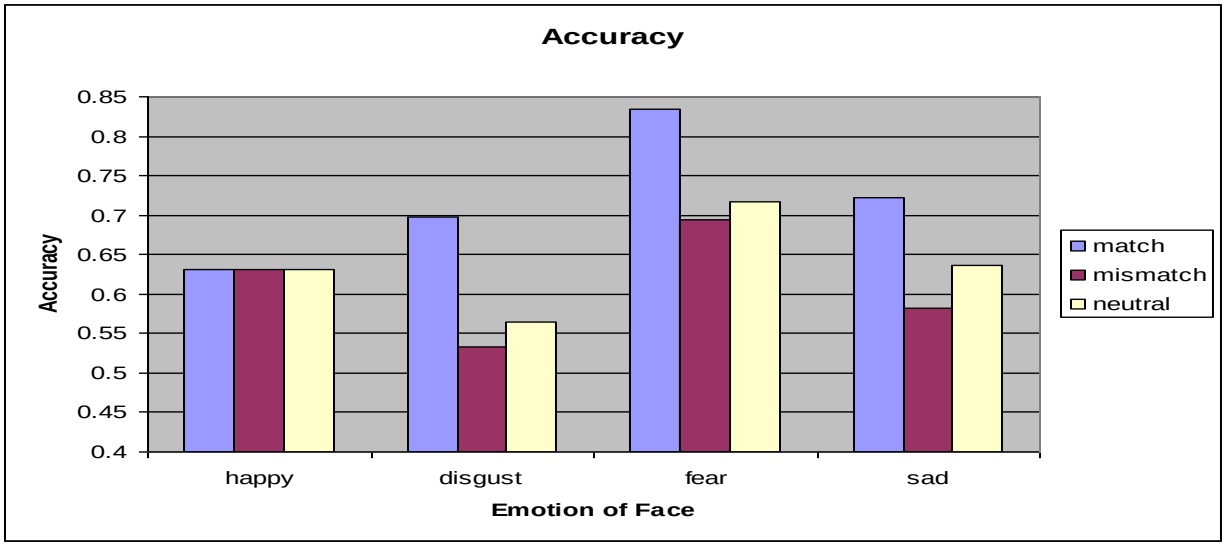

Figure 2.3. Proportion accuracy for matching, mismatching, and neutral contexts

To examine the impact of context on RT, we again conducted a 3 (Context Condition: match vs. mismatch vs. neutral) x 4 (Emotion on the face: happy vs. sad vs. fear vs. disgust) repeated measures ANOVA. There were significant effects for both context, F (2, 302) =47.90, p <.01, eta^2=.24, and emotion on the face F (3, 301) =73.74, p <.01, eta^2=.42. In addition, there was a significant match x emotion interaction, F (6, 298) =8.79, p <.01, eta^2=.15. As can be seen in Figure 2.4[2], for all four emotional faces, participants tended to respond more slowly when the context mismatched the face, and tended to respond more quickly when the context matched the face. The match x emotion interaction reflects the effect of match varying across emotions; for example, the difference between match and mismatch was much larger for happy than for sad facial expressions.

[2] The particular emotion used as context had a large effect on RTs (average Cohen's d = 1.12), whereas it had only a small effect on accuracy (average Cohen's d = .25). Consequently, to illustrate the effect of the degree to which match vs. mismatch of context influenced RTs, we adjusted the RTs based on the average RT for each individual context emotion. For example, the adjusted RT for disgust faces with matching context was computed as the average RT for disgust faces with disgust context divided by the average RT for all faces with disgust context.

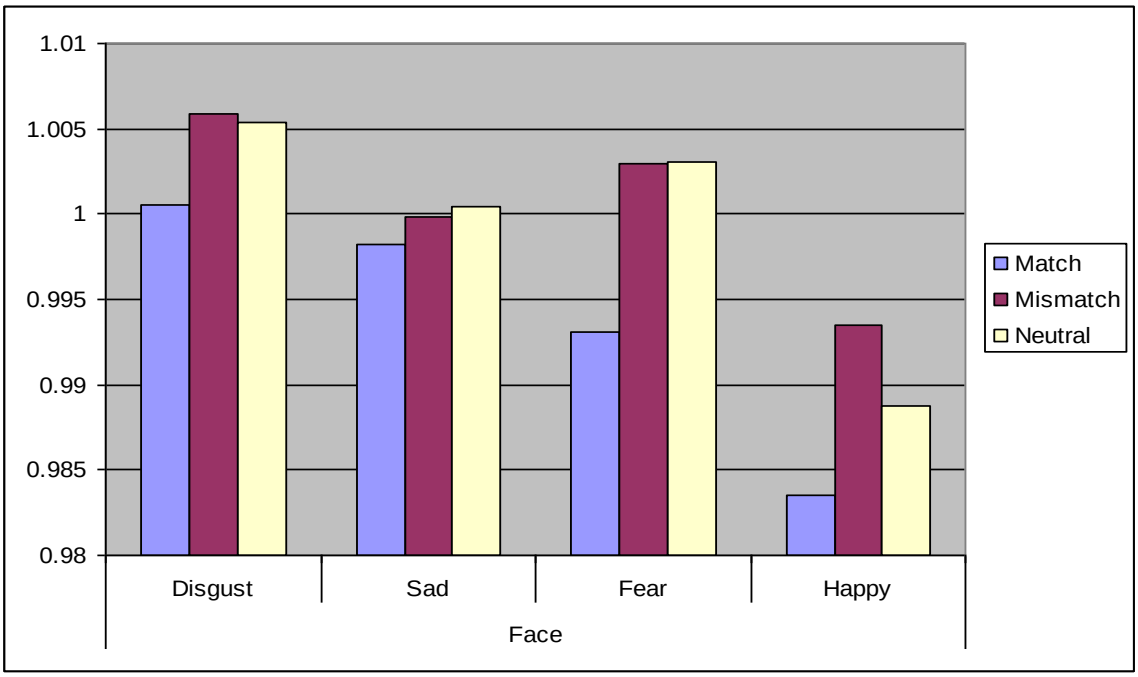

Figure 2.4. Adjusted reaction time for matching, mismatching, and neutral contexts

Discussion

We developed a task that could be easily used by researchers in a variety of settings, with a variety of populations, to study the effects of context on facial affect recognition. While many studies have shown that context influences judgments of what individuals are feeling (e.g., Kim et al., 2004; Carroll & Russell, 1996; Goodenough and Tinker, 1931; Munn, 1940; Fernberger, 1928; Landis, 1929), only three previous studies had examined whether context influences judgments of what is on the face (Leppanen & Hietanan, 2003; Righart & DeGelder, 2008a,b). Like the three previous studies, we found that context generally matters in facial affect recognition judgments, though there are some inconsistent findings across studies. As hypothesized, we found that individuals were generally more accurate when the emotion of the face and context matched and were less accurate when they mismatched. However, emotional

context was not associated with accuracy of decoding happy facial expressions. The absence of context effects for accuracy of decoding happy facial expressions cannot be attributed to ceiling effects, because accuracy rates for happy expressions were lower than for other emotional facial expressions. One possible explanation is that the effects of context on accuracy are especially valuable when distinguishing among emotions of the same valence, and since happiness was the only positively valenced emotion in this task, context did not play a role in accuracy of identifying happy facial expressions. Also as hypothesized, participants were faster at making facial affect recognition judgments when the emotion of the face and context matched than when they mismatched. Perhaps the most important finding in this study is that it is not just the valence of the contextual information that matters, but rather the specific emotion that matters.

Our research went beyond previous research in three significant ways. First, we examined a broader range of emotions than had been examined in previous research. Second, including a larger number of emotions allowed us to examine if facial affect recognition accuracy and RT varied as a function of valence or specific emotions. The third way in which we went beyond previous research was that the instructions and task demands did not explicitly direct the participant's attention to the context as had been done in previous research (i.e., Leppanen & Hietanan, 2003). The reason this is important is that in real life, individuals' attention is not typically directed to contextual information explicitly.

That context influences facial affect recognition judgments has two important implications. First, our results suggest that when making judgments about which emotion an individual is feeling, facial expressions and other relevant information are not judged independently and then combined. Instead, the judgment of the facial expression is itself influenced by the contextual information. In all likelihood, the judgment of the contextual

information is also influenced by the facial expression. Second, our results have implications for developing models of facial affect recognition. That facial musculature influences facial affect recognition judgments is well established. Previous research has found evidence of other aspects of the face, such as its race and gender (e.g., Elfenbein & Ambady; 2002; Hugenberg, 2005), influencing facial affect recognition judgments. The results of this study indicate that there are factors other than the face that can influence facial affect recognition judgments.

Given that research such as ours has demonstrated that the judgment of the emotion on the face is *not* made independently of contextual information, the next step for future research is to explore how and why this happens. For example, it will be important to determine whether the contextual information affects the perceiver's mood which in turn affects the judgments. Even if the impact of contextual information on facial affect recognition is mediated by mood, the effects of mood on facial affect recognition are undoubtedly mediated by cognitive processes. Thus, it will also be critical to determine whether contextual information directly or indirectly (via mood) alters: (a) which information on the face is attended to, how quickly, and for how long; and/or (b) how the information on the face, once attended to, is utilized; and/or (c) the process by which the judgment is made. Additionally, it will be important for future research to explore the different facets/dimensions of context to see how different types of context affect the processing of emotional information differently. For example, future research should continue to explore how visual contextual information can affect judgments differently than olfactory or auditory contextual information. It will also be important to explore how other aspects of context, such as its timing (e.g., context presented prior to the face vs. context presented concurrently, as was the case in the present research) and relevance (e.g., directly connected to the face being judged vs.

independent of the face being judged, as was the case in the present research), affect facial affect recognition.

Chapter 3

Study 2: The Relation between Emotional Numbing and Sensitivity to Emotional Context

PTSD often results in individuals having disrupted emotional experiences ranging from restrictions in the ability to feel or experience emotion (emotional numbing) to experiencing physiological arousal and negative affect (NA) in response to memories of their trauma (APA, 1994). As described by Litz and Gray (2002), "chronic PTSD entails an admixture of intrusive negative affects and problems with emotional experience and expression, particularly positive-feeling states" (p. 203). The present research focused on one specific emotional disturbance associated with PTSD, a restricted range of affect, otherwise known as emotional numbing (EN). EN has been found to be related to a decrease in resiliency resources for individuals with trauma exposure (Johnson, Palimieri, Jackson, & Hobfoll, 2007), and to be closely associated with interpersonal impairment in individuals with war-zone related PTSD (Ruscio, Weathers, King, & King, 2002), suggesting that further research on EN is warranted.

Numerous papers have examined the relation between EN symptoms and other PTSD symptoms (e.g., Yoshihama & Horrocks, 2005; flack et al., 1997), including many factor analytic studies (e.g., Palmieri, Weathers, Difede, & King, 2007b). Whereas there are numerous studies examining whether individuals with PTSD process emotional information differently than do individuals without PTSD (e.g., research using Stroop paradigms; Thomas & Fremouw, 2009; Kimble, Frueh, & Marks, 2009; Beck et al., 2001; McNally, English, & Lipke, 1993), to our knowledge only one study has examined how individuals with different levels of EN perform on tasks that involve the processing of emotional information (Milanak & Berenbaum, 2009). Because PTSD and EN are not isomorphic (e.g., an individual can have EN without having

PTSD; an individual can have PTSD without having EN), finding that PTSD is (or is not) associated with the processing of emotional information does not necessarily mean that EN is (or is not) associated with the processing of emotional information. Consequently, our knowledge of how emotional processing is associated specifically with EN remains quite limited. The present research examined the relation between EN and the effect of emotional context on the processing of emotional information.

Several hypotheses have been proposed regarding the etiology of EN. Three hypotheses regarding EN lead to very different predictions regarding the relation between EN and the effect of emotional context on the processing of emotional information. One theory of EN (Keane et al., 1985), which drew heavily on learning theory, proposed a conditioning model in which EN is viewed as avoidance behavior. Individuals learn to avoid painful memories and emotions by feeling numb, and they are rewarded by not experiencing pain. If Keane et al's (1985) proposed avoidance model of EN is correct, one would expect that: (a) individuals with high levels of EN should avoid attending to emotional contexts that could be potentially threatening and would therefore be less affected by emotional context due to avoidance; and (b) any associations found between EN and the processing of emotional information should not be specific to EN – rather, any associations found with EN should also be found for avoidance.

A second model of EN (Litz et al., 1997), influenced by the relation between EN and other symptoms of PTSD, proposed that EN is the result of the emotional depletion caused by chronic hyperarousal. If Litz et al.'s (1997) model of EN is correct, any associations found between EN and the processing of emotional information should not be specific to EN—rather, any associations found with EN should also be found for hyperarousal. A third model of EN (Milanak & Berenbaum, 2009) was influenced by the results of a study examining the relation

between EN and performance on a word naming priming task. Milanak and Berenbaum (2009) found that EN was associated with the degree to which participants took advantage of valence information to accelerate the processing of subsequently presented similarly valenced stimuli. The results of Milanak and Berenbaum (2009) suggest that differences in emotional processing between individuals with low vs. high levels of EN are most evident when examining how exposure to one emotional stimulus influences the processing of other emotional stimuli. In other words, evidence of EN being associated with the processing of emotional information only became evident when taking into account emotional information that was presented prior to the presentation of the emotional target. Milanak and Berenbaum (2009) did not find a main effect for EN or an EN x target interaction. Instead, they found that the EN x non-target interaction was associated with the processing of emotional information. The finding that the association between EN and emotional processing was only evident when taking into account the non-target emotional prime, suggests that EN is associated with how individuals respond to the temporal sequence, or flow, of emotional information. This, in turn, led Milanak and Berenbaum (2009) to posit that EN is associated with disturbances in emotion regulation processes rather than simply disturbances in emotional responsivity (as indexed by responses to emotional stimuli presented in isolation). If Milanak and Berenbaum's (2009) hypothesis about EN is correct, one would expect to find an association between EN and the impact of emotional context on the processing of emotional information.

To study if and how EN is associated with the processing of emotional information, we took advantage of previous research documenting that accuracy judging facial expressions of emotion tends to be enhanced when the faces are presented in an emotion-matching context, and tends to be diminished when the faces are presented in an emotion-mismatching context

(Leppanen & Hietenan, 2003; Righart & DeGelder, 2008; see Chapter 2). To the best of our knowledge, no previous research has examined whether any aspect of psychopathology, including symptoms of PTSD, are associated with the degree to which emotional processing is influenced by concurrent emotional context. Although facial affect recognition has not been used to examine emotion processing as often as have tasks such as the emotional Stroop, facial affect recognition has been shown to be effective in delineating emotional processing differences in individuals with psychopathology (e.g., mood disorders (e.g., Hale, 1998; Gur et al., 1992) and anxiety disorders (e.g., McClure et. al., 2003))[3]. In fact, based on the evidence suggesting that typical emotional images influence information processing more strongly than do typical emotional words (Beall & Herbert, 2008; DeHouwer & Hermans, 1994), several psychopathology researchers (Gotlib, Krasnoperova, Yue, & Joormann, 2004; Mogg & Bradley, 2005) have recommended using images rather than words.

To summarize, the goal of the present research was to examine the relation between EN and the effect of emotional context on the processing of emotional information. In so doing, we hoped to shed light on three hypotheses/models of EN: (a) the Keane et al. (1985) avoidance model; (b) the Litz et al. (1997) hyperarousal model; and (c) the Milanak and Berenbaum (2009) emotional sequence/flow model.

Method

Participants

Participants were 90 university students (72% female) ranging in age from 18 to 22 (M = 18.8, SD = .9) who had direct trauma exposure (130 students were screened). The ethnic

[3] Several studies have employed facial expressions of emotion when studying PTSD. For example, researchers have examined cortical responses (measured using ERP and fMRI) of individuals with PTSD to emotional facial expressions (e.g., Ehlers et al., 2006; Shin et al., 2005) and memory biases for hostile faces (Paunovic et al., 2003)).

composition of the sample was as follows: 56.7% European American/White, 14.4% Asian American, 10% African American/Black, 10% Latino/a, 3.3% Bi-racial, and 5.6% non-disclosing. Participants received course credit in return for participating. The most common trauma types were transportation accidents, physical assault, or the sudden, unexpected death of someone close to them.

Procedure

In a single session, participants completed the facial affect recognition task described below and a series of questionnaires.

Psychological Trauma. Participants completed the Life Events Checklist (Gray, Litz, Hsu, & Lombardo, 2004), a self-report checklist that measures exposure to potentially traumatic life events. Individuals in this sample personally experienced a range of traumatic life events (between 1 and 6) with the mean number of events being 2.6.

Post-Traumatic Stress Disorder symptomology was assessed using the PTSD Checklist Civilian version (PCL-C; Weathers et al., 1993) which measures the frequency of the 17 PTSD symptoms included in the DSM-IV. Individuals in this study had PCL scores ranging from 17 to 79 with an average PCL score of 34.6 (SD = 12.2). The highest score possible (rating all 17 symptoms as a extremely severe) would be a score of 85. A score of 34 would mean an average rating of a 2 (a little bit) for each of the 17 symptoms; however, it is also possible for individuals to rate some symptoms high and others low and still obtain a score of 34. Therefore, the average score in this sample is indicative of moderate levels of PTSD symptoms. Moderate to strong correlations have been found between the PCL and other PTSD measures (Weathers et al., 1993). The PCL-C has been validated in a variety of civilian samples (e.g., Ruggiero et al., 2003; Walker et al., 2002; Smith et al., 1999).

Emotional Numbing scores were calculated by averaging the responses on the PCL-C to the 5 PTSD symptoms that comprise the EN symptom factor (Palmieri, Weathers, Difede, & King, 2007): restricted affect, diminished interest, detachment, foreshortened future, and amnesia. Scores ranged from 5 to 24, with a mean EN score of 8.8 (SD = 4.0). Analyses were conducted using the continuous variable, but for graphing purposes, high and low EN groups were created (as described in greater detail below). The results of the analyses reported below did not change when we used the 3-item EN symptom factor (restricted affect, diminished interest, and detachment), leaving out foreshortened future and amnesia.

Effect of Context on Emotional Processing was measured using the Contextual Recognition of Affective Faces Task (CRAFT; see Chapter 2), in which participants view faces (male and female faces of Sub-Saharan African, East Asian, and European decent) displaying different facial expressions (i.e., neutral, happiness, fear, sadness, and disgust) superimposed upon emotionally valenced (i.e., happiness, fear, sadness, and disgust) and neutral images.

The CRAFT is composed of 168 trials (each of the 54 face images was presented three times – once paired with a neutral background image, once paired with the matching emotion context image, and once paired with a mismatching emotion context image). The order in which the 168 trials were administered was randomized separately for each participant. On each trial, the participant is presented with a single face image superimposed upon a single emotionally valenced or neutral image. All context images covered the entire computer monitor; the size of the face superimposed upon the context image was identical in all trials. Participants responded using a keyboard that had five keys labeled with the following emotions: "happy," "sad," "fear," "disgust," and "neutral." Participants had to select, by pressing one of the five labeled keyboard keys (using the index finger of their dominant hand), which of the aforementioned labels most

accurately described the emotional expression on the face. They read the following instructions on the screen: "You will be seeing 168 sets of images. Each image is made up of a background picture and a picture of a face. The faces will appear in different locations on the screen. Your task is to decide which of the five emotional expressions is being shown by the face."

Following Kerns and Berenbaum (2000), reaction times shorter than 300 ms were eliminated. RTs were also removed from analyses if they were: (1) smaller than and/or larger than 3 standard deviations of the group grand mean; and/or (2) smaller than and/or larger than 3 standard deviations of the individual participant's mean. Finally, a log linear transformation was used on the RT data to correct for skewness/kurtosis.

There were 3 context conditions: matching (both face and image are the same emotion), mismatching (face and image are different emotions), and neutral (emotional face on a neutral image). Each type of emotional facial expression (happy, sad, fear and disgust) was presented 36 times (12 times in the matching condition, 12 mismatching, and 12 neutral), and neutral facial expressions were presented 24 times (12 matching and 12 mismatching). For example, for fear facial expressions: (a) 12 fear faces on fear images were presented; (b) 12 fear faces on mismatching contexts (4 on happy contexts, 4 on sad contexts, and 4 on disgust contexts) were presented; and (c) 12 fear faces on neutral contexts were presented. Images were displayed on the screen until the participant made a response. As soon as the participant made a response, the next face superimposed on an image would appear[4.] There were multiple positions where the face could be located (top or bottom left, top or bottom right, or center). Multiple positions were used so that the participant would have to scan each image. Had the face always been placed in the same position, participants might have learned over trials to focus exclusively on the face and to ignore the background context information).

[4] Examples of the combinations of images and facial expressions are available upon request.

Results

As expected, collapsing across all participants, there was a significant effect of context, χ^2 (df = 2) = 57.67, $p < .001$, with performance tending to be most accurate in the match condition (average accuracy = 78 percent) and less accurate in the mismatch and neutral conditions (64 percent for both).

Having found that individuals respond more accurately in the match condition, we proceeded to examine if context effects would be moderated by PTSD symptoms. To do so we conducted a 3 (Within-Subjects Context Condition: match vs. mismatch vs. neutral) x 4 (PTSD symptom clusters: re-experiencing vs. avoidance vs. emotional numbing vs. hyperarousal; these were treated as continuous between-subjects variables) repeated measures analysis of variance, using the number of correctly identified facial expressions of emotion in each condition as the dependent variables[5]. As predicted, there was a significant Context x EN interaction, $F(2,84)=5.43$, $p=.006$, $eta^2=.115$. There were no significant main effects or interactions involving the other PTSD symptoms. We also re-ran the analysis including NA, and the context x EN interaction remained significant ($F(2,84)=5.43$, $p=.006$, $eta^2=.114$) providing evidence that the interaction was not better accounted for, nor could be explained away, by NA. The results remained the same when running separate analyses for each symptom factor instead of entering all four symptom factor scores in a single analysis. Supplementary analyses did not reveal any evidence of the EN x Context interaction being moderated by the type of emotion on the face[6].

[5] Analyses were conducted for each emotional facial expression separately, and no significant results emerged. Therefore, we collapsed across emotion of the face for the reported results.

[6] The 3 x 4 ANOVA was also run for an EN factor composed of 3 symptoms (excluding amnesia and foreshortened future), and the Context x EN interaction was still significant (p=.04, eta2=.075).

The nature of the EN x Context interaction is illustrated in Figure 1, in which we present facial affect recognition accuracy in the three conditions for individuals with lower levels of EN (defined as little to no endorsement of EN symptoms; i.e., scores of 8 or less out of 25 on the sum of EN symptoms, average EN score = 6.2) and higher levels of EN (defined as moderate or higher endorsement of EN symptoms; i.e., scores of 9 or higher on the sum of EN symptoms, average EN score = 12.6). As can be seen in Figure 3.1, individuals with higher levels of EN were more affected by the context than were individuals with lower levels of EN. Specifically, compared with individuals with lower levels of EN, individuals with higher levels of EN were more accurate when the emotion of the face and the background were the same or when the background was neutral (no emotion), and less accurate when the emotion of the face and background were not the same.

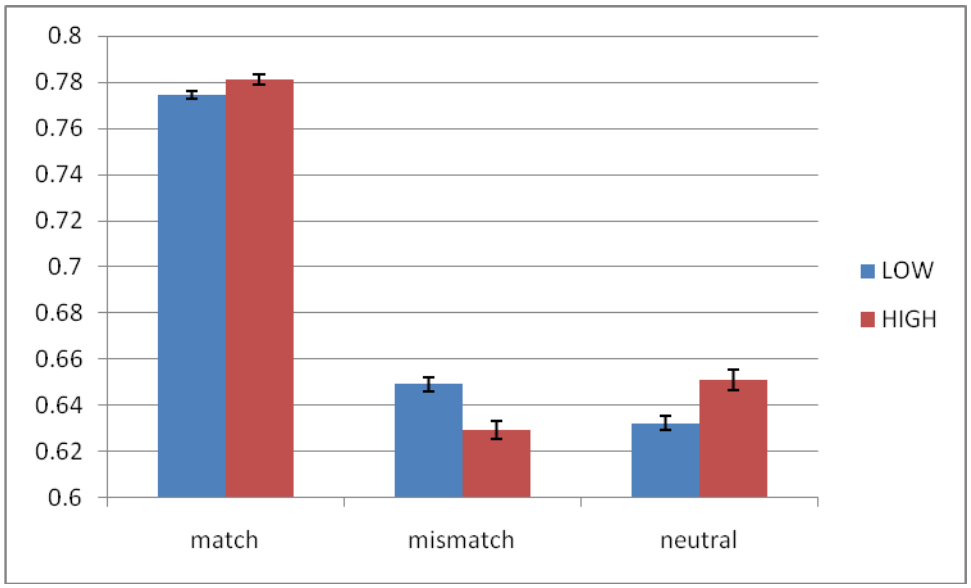

Figure 3.1. Facial affect recognition accuracy across the three context conditions for individuals with higher and lower levels of EN.

Parallel analyses examining RT rather than accuracy did not reveal any significant symptom main effects or context x symptom interactions. Thus, it is unlikely that the significant accuracy results are reflective of speed-accuracy trade-offs.

Discussion

The present research examined the relation between EN and the effect of emotional context on the processing of emotional information in the hopes of shedding light on three hypotheses/models of EN: (a) the Keane et al. (1985) avoidance model; (b) the Litz et al. (1997) hyperarousal model; and (c) the Milanak and Berenbaum (2009) emotional sequence/flow model. The results of the current study supported the Milanak and Berenbaum (2009) hypothesis. Consistent with previous research (Milanak & Berenbaum, 2009), the results of the present study indicate that EN is associated with the processing of emotional information. Specifically, we found differences in emotional processing between individuals with low vs. high levels of EN when examining their judgments of emotional facial expressions presented in the context of emotional images. Compared to individuals with lower levels of EN, individuals with higher levels of EN had heightened sensitivity to emotional context; they benefited more (were more accurate) when the emotion of the face and background matched and were harmed (less accurate) when they mismatched. This provides additional evidence that EN is associated with how individuals are affected by non-target emotional stimuli when responding to target emotional stimuli. Additionally, the finding that an individual factor of PTSD was related to disturbances in emotional processing when other PTSD factors were not provides support for examining specific factors of PTSD separately instead of just exploring PTSD as a whole.

Both Milanak and Berenbaum (2009) and the current research found that EN is associated with emotional information processed in the context of other emotional information. Interestingly, however, while Milanak and Berenaum (2009) found that individuals with higher levels of EN were under-influenced by emotional context, the present research found that individuals with higher levels of EN were over-influenced by emotional context. In other words, in both the previous research and the current study, we found that it was not a main effect for EN nor was there an EN by target stimulus interaction. It was the EN x non-target interaction that was significant. There are several possible explanations for these differences. First, the current research presented emotional stimuli concurrently, whereas Milanak and Berenbaum (2009) presented emotional stimuli one after the other. Second, the current study employed facial expression and visual image stimuli, whereas Milanak and Berenbaum (2009) employed verbal cues (words read on the screen). Third, the task used in the current research (CRAFT) was a task that explicitly focused participants' attention on emotion, whereas Milanak and Berenbaum (2009) did not include any emotional ratings in the task. Thus, it will be worthwhile for future research to examine, in the same set of participants: (a) emotional stimuli presented both concurrently and subsequently; (b) responses to both verbal and non-verbal emotional stimuli; and (c) performance on tasks that do and do not explicitly focus participants' attention on emotion.

The results of the present study were not consistent with what would have been anticipated based on the other two hypotheses/models of EN. Specifically, for the Keane et al. (1985) model, one would have expected individuals with high levels of EN to avoid attending to emotional contexts that could be potentially threatening/provoking painful thoughts and memories. In contrast, however, individuals with higher levels of EN were more strongly

affected by the emotional context (positively and negatively valenced alike) than were individuals with lower levels of EN. Also, based on the Keane et al. (1985) model, one would have expected that any associations found between EN and the processing of emotional information would not have been specific to EN, but would instead be mirrored by avoidance. However, there was no significant context by avoidance interaction. Similarly, for Litz et al.'s (1997) model, one would have expected that any associations found between EN and the processing of emotional information would not have been specific to EN, but would instead be mirrored by hyperarousal. However, there was no significant context by hyperarousal interaction. The heightened sensitivity to emotional context was specific to individuals with higher levels of EN, not hyperarousal, therefore not supporting what would have been expected based on Litz's (1997) model. Of course, our results in no way suggest that EN and hyperarousal are independent; they do, however, suggest that EN and hyperarousal are differentially associated with emotional processing.

Knowing that individuals with PTSD may or may not experience EN, and that not all individuals who experience EN after a traumatic life event develop PTSD, we chose to examine EN separately from PTSD (even though the majority of previous research has examined PTSD as a whole). We found that one specific symptom factor, EN, was associated with the processing of emotional information. This finding may be useful clinically for several reasons. First, it alerts clinicians to the potential deficits and/or biases that their PTSD clients may have if they are experiencing EN. Second, it alerts clinicians to potential emotional deficits and/or biases of clients who do not meet diagnostic criteria for PTSD, but who happen to be experiencing EN. Finally, understanding how individuals with EN process emotional facial expressions in context (which is equivalent to how most faces are viewed and perceived in everyday life) is useful for

clinicians because facial expressions play an integral role in interpersonal relationships (Nachson, 1995).

While the results of the current study provide further support for EN being associated with emotional context and emotional processing, it will be important for future research to explore the specific mechanism that underlies this relation. One way to examine the mechanism affecting emotional processing and attention is to use eye-tracking (measuring eye movements/saccades and fixation duration). Specifically, as individuals complete the CRAFT task, every eye movement and the duration that they fixate on any part of the image could be recorded to examine if individuals with higher or lower levels of EN spend more time looking at the faces or the background images, and whether this "attention" allocation changes with different conditions. It is possible, for example, that the context directs attention toward the face or draws attention away, both of which can affect accuracy. Further, what gets attended to may depend on the emotional congruence of the image and face emotions, and PTSD symptoms, such as EN. Additional research strategies, such as measuring event related potentials while participants are processing emotional information, are also likely to provide clues to the mechanism underlying the association between EN and emotional processing.

Both the current and our previous research examined groups of individuals with a variety of traumatic experiences. As a result, it seems unlikely that our findings are specific to a single type of trauma. Nonetheless, future research should examine the relation between EN and emotional processing in specific trauma experiences since it is possible that the mechanism responsible may be differentially influenced by the type of trauma. Additionally, it should be noted that this research used a student sample, not a treatment seeking sample. Nonetheless, we were able to obtain a wide range of reported EN symptom severity/frequency. However,

individuals with extremely high levels of EN were probably underrepresented in our sample, just as individuals with extremely low levels of EN would likely be underrepresented in a treatment-seeking sample. We predict that samples that include large numbers of individuals with both very low and very high levels of EN will reveal even stronger associations between EN and emotional processing than those found in the present study.

Chapter 4

Study 3: Trauma, PTSD, Emotional Processing, and Eyetracking

According to the DSM-IV (APA, 1994), a traumatic event is characterized as an event that poses a potential or actual threat of death and/or serious injury or an actual or potential threat to one's physical integrity. Examples of a traumatic event include: transportation accidents, physical assault with or without a weapon, sexual assault, sudden death of someone close to you, and military and warzone exposure. Sadly enough, a large portion of individuals in the United States have experienced a traumatic event at some point in their lifetime. In large epidemiological studies, Resnick et al. (1993), Kessler et al. (1995), and Breslau (2009) found that approximately three-quarters of the population has experienced a traumatic life event. Furthermore, Breslau (2009) reported that slightly less than 10% of trauma victims developed post-traumatic stress disorder (PTSD), an anxiety disorder that can develop following a traumatic life experience.

PTSD often results in individuals having disrupted emotional experiences including restrictions in the ability to feel or experience emotion (emotional numbing) (APA, 1994). Therefore, numerous researchers have examined how PTSD is associated with disturbances in emotional processing. Investigators have consistently found that individuals with PTSD differ from controls in their processing of emotionally valenced stimuli. Using modified versions of the emotional Stroop task, researchers have generally found that individuals with PTSD respond differentially to threat words associated specifically with the type of trauma they experienced (e.g., words such as crash or highway for individuals who develop PTSD following motor vehicle accidents), but do not respond differentially to other threat, positive, or neutral words

(e.g., McNally, English, & Lipke, 1998; Thrahser & Dalgleish, 1994). Given that recent research has suggested that typical emotional images influence information processing more strongly than do typical emotional words (Beall & Herbert, 2008; DeHouwer & Hermans, 1994), several psychopathology researchers (Gotlib, Krasnoperova, Yue, & Joormann, 2004; Mogg & Bradley, 2005) have recommended using images rather than words. In fact, psychopathology researchers are now using facial expressions of emotion more frequently to examine emotional processing (e.g., Hale, 1998; Gur et al., 1992; McClure et. al., 2003).

Four previous studies have found that the accuracy of judging facial expressions of emotion tends to be enhanced when the faces are presented in an emotion-matching context, and tends to be diminished when the faces are presented in an emotion-mismatching context (Leppanen & Hietenan, 2003; Righart & DeGelder, 2008; see Chapter 2). However, Milanak and Berenbaum (Chapter 2) found that emotional context was not associated with accuracy of decoding happy facial expressions. Milanak and Berenbaum (Chapter 3) took advantage of these findings and used a contextual facial affect recognition task to study if and how specific symptom factors of PTSD (e.g., emotional numbing, avoidance) are associated with the processing of emotional information in individuals with trauma histories. They found that only one symptom factor of PTSD, emotional numbing (EN), was associated with the degree to which context influenced facial affect recognition. Specifically, Milanak and Berenbaum (Chapter 3 found differences in emotional processing between individuals with low vs. high levels of EN when examining their judgments of emotional facial expressions presented in the context of emotional images. Compared to individuals with lower levels of EN, individuals with higher levels of EN had heightened sensitivity to emotional context; they benefited more (were more

accurate) when the emotion of the face and background matched and were harmed (less accurate) when they mismatched.

Although the results of Milanak and Berenbaum (chapter 3) suggest a link between EN and the impact of emotional context on facial affect recognition, the precise mechanism(s) underlying this relation remains unknown. One way to examine the factors that influence the processing of emotional information is to use eye-tracking (measuring eye movements/saccades and fixation duration). Specifically, as individuals complete a facial affect recognition task, every eye movement and the duration that they fixate on any part of the face and/or a background context image can be recorded. We can then examine if individuals with higher or lower levels of the four PTSD symptom factors (i.e., EN, avoidance, hyperarousal, and re-experiencing) spend more time looking at the faces or the background images, and whether this "attention" allocation changes with different conditions (e.g., the emotion of the face matches the emotion of the background context, the emotional face is presented on a neutral image). If individuals with higher and lower levels of PTSD symptoms show similar patterns of scanning and fixation, we can begin to posit that the differences in behavioral responses (e.g., accuracy and RT) are attributed to how the visual information is processed after it has been attended to. On the other hand, if differences in scanning and fixation are detected, we can begin to hypothesize that the underlying mechanism contributing to differences in accuracy and RT are due to different patterns of obtaining emotional information, not just differential processing of that emotional information. It is possible, for example, that the context directs attention toward the face or draws attention away, both of which can affect accuracy. Further, what gets attended to may depend on the emotional congruence of the image and face emotions, and PTSD symptoms, such as EN or hyperarousal.

In summary, the present research utilized eyetracking to examine how individuals with trauma histories perceive and process emotional information, specifically emotional facial expressions presented in the context of emotional images.

Method

Participants

Participants were 98 university students. Because we were interested in individuals with trauma histories, we limited our analyses to those 76[7] individuals who had direct trauma exposure and who met PTSD Criterion A (the assessments of which are described below). Participants included in the analyses (54% female) ranged in age from 18 to 30 (M = 19.4, SD = 1.7). The ethnic composition of the sample was as follows: 55% European American/White, 32% Asian American, 5% Latino/a, 4% African American/Black, and 4% Bi-racial. Participants received course credit in return for participating.

Procedure

In a single session, participants completed the facial affect recognition task described below, a UFOV (useful field of view) task described below, and a series of questionnaires (not all will be examined in this paper).

Effect of Context on Emotional Processing was measured using the Contextual Recognition of Affective Faces Task (CRAFT; see Chapter 2), in which participants view faces (male and female faces of Sub-Saharan African, East Asian, and European decent) displaying different facial expressions (i.e., neutral, happiness, fear, sadness, and disgust) superimposed upon emotionally valenced (i.e., happiness, fear, sadness, and disgust) and neutral images.

[7] Participants in this research (Study 3) were different than those in Studies 1 and 2.

The CRAFT is composed of 168 trials (each of the 54 face images was presented three times – once paired with a neutral background image, once paired with the matching emotion context image, and once paired with a mismatching emotion context image). The order in which the 168 trials were administered was randomized separately for each participant. On each trial, the participant is first presented with a screen with a fixation cross, and then a single face image superimposed upon a single emotionally valenced or neutral image which remained on the screen for 5 seconds. All context images covered the entire computer monitor; the size of the face superimposed upon the context image was identical in all trials. After 5 seconds the image disappeared and a new screen listing the five emotion labels was presented. This prompt remained on the screen until participants responded using a keyboard that had five keys labeled with the following emotions: "happy," "sad," "fear," "disgust," and "neutral." Participants had to select, by pressing one of the five labeled keyboard keys (using the index finger of their dominant hand), which of the aforementioned labels most accurately described the emotional expression on the face. After they made their choice, the screen with the fixation cross appeared again. They read the following instructions on the screen: "You will be seeing 168 sets of images. Each image is made up of a background picture and a picture of a face. The faces will appear in different locations on the screen. Your task is to decide which of the five emotional expressions is being shown by the face."

Following Kerns and Berenbaum (2000), reaction times shorter than 300 ms were eliminated. RTs were also removed from analyses if they were: (1) smaller than and/or larger than 3 standard deviations of the group grand mean; and/or (2) smaller than and/or larger than 3 standard deviations of the individual participant's mean. Finally, a log linear transformation was used on the RT data to correct for skewness/kurtosis.

There were 3 context conditions: matching (both face and image are the same emotion), mismatching (face and image are different emotions), and neutral (emotional face on a neutral image). Each type of emotional facial expression (happy, sad, fear and disgust) was presented 36 times (12 times in the matching condition, 12 mismatching, and 12 neutral), and neutral facial expressions were presented 24 times (12 matching and 12 mismatching). For example, for fear facial expressions: (a) 12 fear faces on fear images were presented; (b) 12 fear faces on mismatching contexts (4 on happy contexts, 4 on sad contexts, and 4 on disgust contexts) were presented; and (c) 12 fear faces on neutral contexts were presented. Images were displayed on the screen until the participant made a response. As soon as the participant made a response, the next face superimposed on an image would appear. There were multiple positions where the face could be located (top or bottom left, top or bottom right, or center). Multiple positions were used so that the participant would have to scan each image. Had the face always been placed in the same position, participants might have learned over trials to focus exclusively on the face and to ignore the background context information).

Psychological Trauma. We operationalized the experience of psychological trauma as the individual having indicated that they personally experienced a stressful/traumatic event. The Life Events Checklist (Gray, Litz, Hsu, & Lombardo, 2004), a self-report checklist that measures exposure to potentially traumatic life events, lists the 17 most common stressful/traumatic experiences that individuals could encounter (e.g., transportation accidents, sudden, unexpected death of someone close to them, natural disaster, sexual or physical abuse). Participants rate each of the potentially stressful/traumatic events as to whether: (1) it happened to them (direct trauma exposure), (2) they witnessed it; (3) they learned about it; (4) they do not remember; or (5) it does not apply. The most common trauma types reported by participants in this study were

natural disasters, transportation accidents, unwanted sexual experiences, and sudden, unexpected death of someone close to them. The mean number of traumatic life events experienced by participants was 2.8 (ranging from 1 to 10 traumatic life experiences).

Criterion A was assessed using a questionnaire created for this study. Participants reported which of the life events that they experienced directly (as indicated on the Life Events Checklist) was the most traumatic, when it occurred, if there was actual or threat of death, injury, or threat to physical integrity for themselves or others; and they also reported if they responded to the traumatic event with feelings of horror, helplessness, and/or intense fear. The responses of all 76 participants who endorsed having directly experienced a traumatic event indicated that they met Criterion A.

PTSD sequelae were measured using the PTSD Checklist – Civilian version (PCL; Weathers, Litz, Herman, Huska, & Keane, 1993), a self-report questionnaire measuring frequency and severity of the 17 PTSD symptoms as defined by the DSM-IV (APA, 1994). Symptoms include re-experiencing (nightmares, flashbacks), avoiding people and places that remind them of the event, feeling emotionally numb, and being easily startled. Participants rate each symptom on a scale from 1 (not at all) to 5 (extremely). Researchers such as Blanchard, Jones-Alexander, Buckley, and Forneris (1996) have shown evidence that the PCL is psychometrically strong (e.g., an alpha of .94 for the total scale) (also see Ruggiero, Del Ben, Scotti & Rabalais, 2003).

Eye tracking. We used the EyeLink II eye tracker which is a commercially-available eye tracker. The EyeLink II eye tracker (which records eye position every 2 msec) is a device that reflects infrared light off the lens and the cornea of the eye. The lens, cornea, and other parts of the eye absorb a small amount of energy from the infrared light, but the energy is less than 1% of

the Maximum Permissible Exposure level as certified by the American Standards Institute (ANSI Z 136.1-1973). This is about as much energy as you get on a bright sunny day. As individuals complete the CRAFT task, every eye movement and the duration that they fixate on any part of the image will be recorded. To define a fixation, the eyelink program uses an algorithm that picks out participant blinks and saccades. The remaining periods of time between blinks and saccades are labeled as fixations.

For each facial expression of emotion for each type of background image, we examined the: (1) fixation location (whether they were fixating within the interest area (the area of the face) or outside the interest area (fixating on the background)); (2) total number of fixations; (3)total number of saccades (how many times they move their eyes and scan the entire image); and (4) amplitude of the saccades.

We divided the number of fixations that an individual made within the interest area (i.e., fixations on the face) by the number of total fixations made on correct trials. Proportion scores were calculated for each context condition (match, mismatch, and neutral) collapsed across emotions, as well as for each individual emotion for each context (e.g., happy faces on happy contexts, sad faces on fear contexts).

Useful Field of View (UFOV) was measured using a task in which participants searched for a white triangle within a circle among square distracters in a briefly presented (11ms) display. Targets were arranged in eight radial spokes around a square in the center of the display, and they occurred with equal probability on each arm at eccentricities of 10^{o}, 20^{o}, and 30^{o} from the center of fixation. After the target item was presented, a mask display consisting of random black and white lines and shapes was presented for 5 ms. After the mask display disappeared, a new screen appeared showing lines representing the eight radial arms prompting participants for a

response. Subjects had to select the correct radial arm on which the target had appeared. Accuracy of responses was recorded. Participants completed 24 practice trials (with a presentation duration of 170 ms) followed by 120 experimental trials.

Results

To determine if there was any association between individual PTSD symptom clusters and participants' useful field of view (UFOV; the area in which an individual can perceive visual information without turning or moving their head), we conducted a mixed factors ANOVA with eccentricity as a within subjects factor (10, 20, and 30 degrees) and PTSD symptom factors (re-experiencing, avoidance, EN, and hyperarousal) as continuous between-subjects factors. There was a main effect for eccentricity (F=3.58 (2, 55), p<.05, eta2=.12) with lower accuracies at higher eccentricities (Means = .46, .35, and .27, respectively, for 10, 20, and 30 degrees). There were no effects for PTSD symptoms or any significant interactions.

To examine the impact of context on the proportion of fixations looking at the face, we conducted a 3 (Within-Subjects Context Condition: match vs. mismatch vs. neutral) x 4 (Within-Subjects Emotion on the face: happy vs. sad vs. fear vs. disgust) x 4 (PTSD symptom clusters: re-experiencing vs. avoidance vs. emotional numbing vs. hyperarousal; these were treated as continuous between-subjects variables) repeated measures analysis of variance. Consistent with our previous research, there was a significant main effect for context, F=10.01 (2,70), p<.01, eta^2=.22. Across all emotions, individuals spent the most time fixating on the face (the highest proportion of fixations) when the background context was neutral (M = .201, SD = .052) compared to mismatching (M = .194, SD = .046) and matching (M = .186, SD = .047) conditions. There was also a significant main effect for emotion, F=3.27 (3,69), p<.05, eta^2=.12. Individuals spent the lowest proportion of fixations on the sad faces (.16), followed by fear faces (.19), then

happy faces (.21), and the highest proportion on disgust faces (.22). There was also a significant context x emotion 2-way interaction, F=6.90 (6,66), p<.01, eta^2=.39.

For the context x emotion interaction, as can be seen in Figure 4.1, there was a different pattern of fixations for each emotion. The patterns of disgust and fear were relatively similar, with the greatest number of fixations for mismatching trials. In contrast, for happiness, there were far more fixations for neutral trials than for matching and mismatching trials. There were relatively few fixations of the sad face, with context condition making little difference.

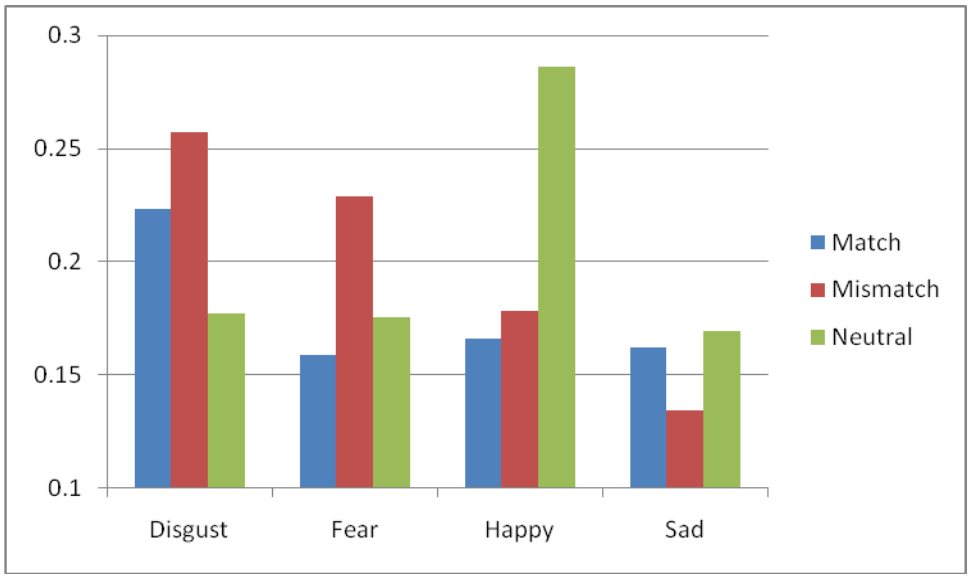

Figure 4.1. Context x Emotion interaction for proportion of fixations on the face

Follow-up post-hoc repeated measures ANOVAs were run to examine differences in context effects for each individual emotion. There was a significant context effect for happy faces (F=82.14 (2, 74), p < .01, eta2 = .69), fear faces (F = 32.30 (2, 74), p < .01, eta^2 = .47), disgust faces (F=21.71 (2, 74), p <.01, eta^2=.37), and sad faces (F=5.84 (2, 74), p < .01, eta^2 = .14). We then conducted paired-samples t-tests to compare individual contexts within each

emotion. There were 75 degrees of freedom for each analysis. The majority of the comparisons were significant at $p < .01$. In addition, for fear faces, there was a significant difference between match and neutral contexts at $p < .05$. Also, there were two comparisons that were not significant: match and mismatching contexts for happy faces and match and neutral contexts for sad faces.

In terms of PTSD symptoms, there was a significant Context x Hyperarousal 2-way interaction, $F=3.33$, $p<.05$, $eta^2=.09$, and trends for Emotion x Re-experiencing: F=2.50 (3,69), p=.07, $eta^2=.10$ and Emotion x Avoidance: F=2.46 (3,69), p=.07, $eta^2=.10$. Finally, there was a significant Emotion x Avoidance x Context 3-way interaction, $F=2.56$ (6,66), $p<.05$, $eta^2=.19$, and a trend toward a 3-way Context x Emotion x EN interaction, F=1.84 (6,66), p=.11, $eta^2=.14$.

The nature of the Context x Hyperarousal interaction is illustrated in Figure 4.2, in which we present the proportion of fixations within the interest area (i.e., on the face) for accurate trials for individuals with lower levels of hyperarousal (defined as little to no endorsement of hyperarousal symptoms; i.e., scores of 9 or less out of 25 on the sum of hyperarousal symptoms, average hyperarousal score = 6.9) and higher levels of hyperarousal (defined as moderate or higher endorsement of hyperarousal symptoms; i.e., scores of 10 or higher on the sum of hyperarousal symptoms, average hyperarousal score = 12.4). As can be seen in Figure 4.2, individuals with higher levels of hyperarousal generally spent less time looking at the face and more time looking at the context than did individuals with lower levels of hyperarousal. This difference was especially pronounced for neutral contexts. Follow-up post hoc correlations showed that the proportion of fixations on faces in the neutral context condition was significantly correlated with hyperarousal ($r = -.27$, $p<.05$), but was not significantly correlated with hyperarousal for matching or mismatching contexts ($r = -.08$, $p=.50$ and $r = -.16$, $p =.18$,

respectively). Correlations were compared using the formula recommended by Meng, Rosenthal, and Rubin (1992). The correlation between hyperarousal and fixations when the context was neutral differed significantly from the correlation between hyperarousal and fixations when the context was matching, z=2.26, p = .01, and differed, albeit not significantly, from the correlation between hyperarousal and fixations when the context was mismatching, z=1.18, p = .12.

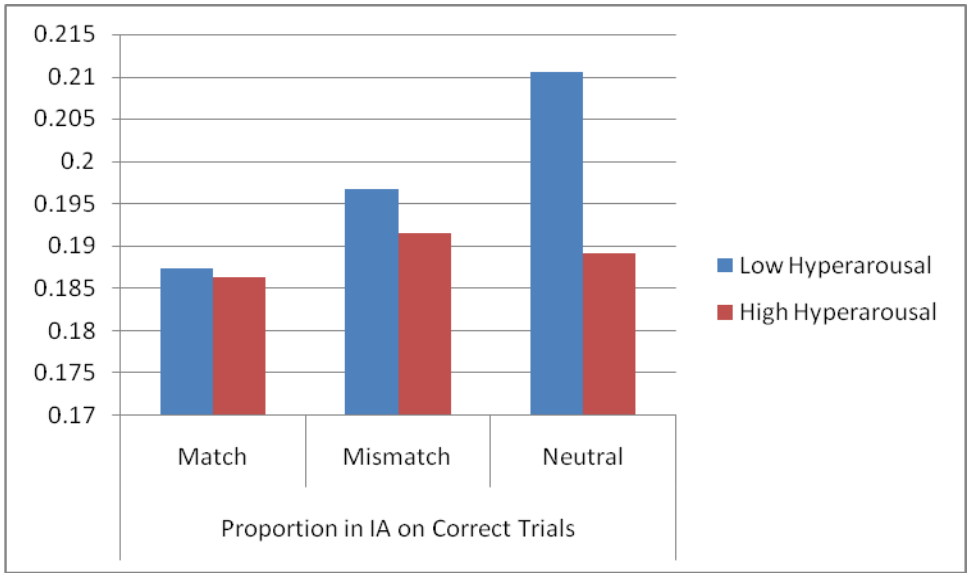

Figure 4.2. Proportion of fixations on the face for each context for individuals with lower and higher levels of hyperarousal

The nature of the Emotion x Re-experiencing interaction is shown in Figure 4.3. As can be seen in Figure 4.3, individuals with higher levels of re-experiencing spent less time fixating on the face than individuals with higher levels of re-experiencing for disgust, fear, and sad faces. However, there was very little difference in fixation proportion between individuals with higher and lower levels of re-experiencing for happy faces. Post-hoc correlations were conducted, and there were no significant correlations between re-experiencing and any of the individual

emotions. We again compared the correlations using the formula suggested by Meng, Rosenthal, and Rubin (1992).The differences in magnitudes of correlations were generally weak. The biggest difference was between re-experiencing and fixations for happy faces and re-experiencing and fixations for fear faces, $z = 1.15$, $p = .13$.

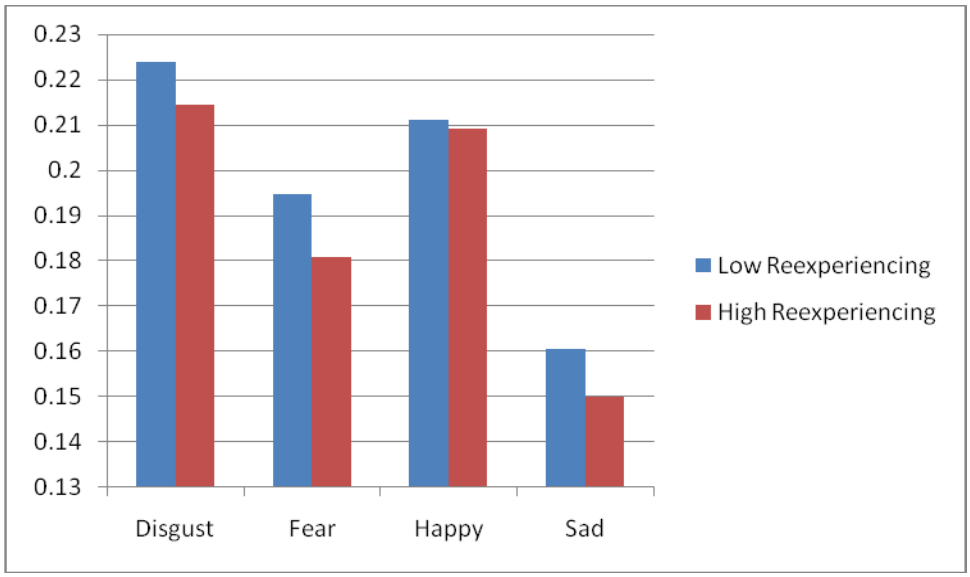

Figure 4.3. Proportion of fixations on the face for individuals with lower and higher levels of re-experiencing for each emotional facial expression

Figure 4.4 illustrates the Emotion x Avoidance interaction. As can be seen in Figure 4.4, individuals with high levels of avoidance fixated on disgust, happy, and sad faces less than did individuals with lower levels of avoidance. In contrast, individuals with high levels of avoidance fixated on fear faces more than did individuals with lower levels of avoidance. There were no significant findings for post-hoc follow up correlations between avoidance and any of the individual emotions. When comparing the correlations (Meng, Rosenthal, & Rubin, 1992) the

biggest difference was between: (1) avoidance and fear faces vs. avoidance and happy faces, z = -1.47, p = .07.

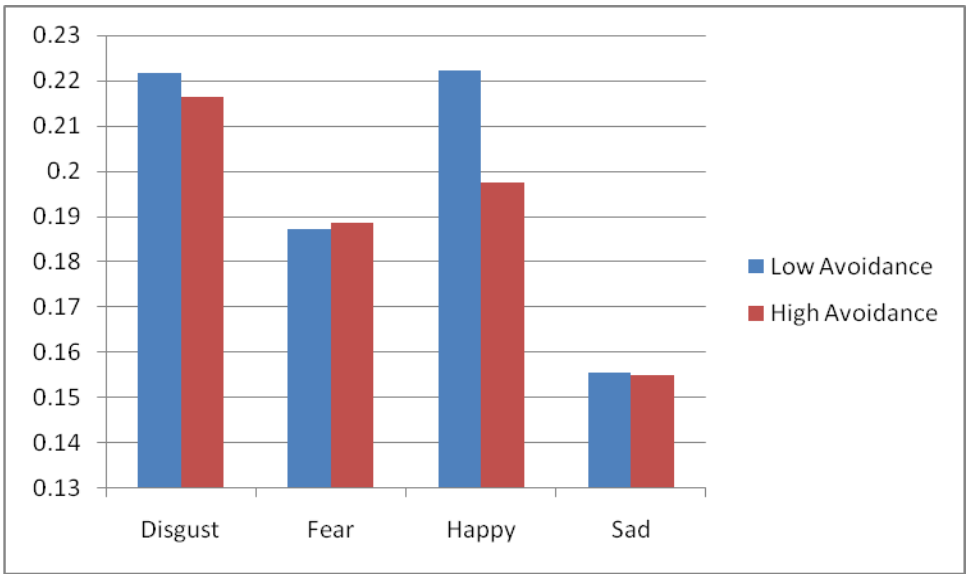

Figure 4.4. Proportion of fixations on the face for individuals with lower and higher levels of avoidance for each emotional facial expression

There was evidence of the Avoidance x Emotion interaction being further moderated by context. Follow up repeated measures ANOVAs were conducted to further explore the nature of this trend for a 3-way interaction. We ran 4 (emotion: sad vs. fear vs. disgust vs. happy) x 4 (PTSD symptom factors: re-experiencing vs. avoidance vs. EN vs. hyperarousal) repeated measures ANOVAS for each context condition separately. The Avoidance x Emotion interaction described above was especially pronounced in the mismatching condition, $F = 4.73$, $p < .01$, $eta^2 = .17$, and was not significant in the matching or neutral conditions. As can be seen in Figure 4.5, the pattern described in Figure 4.4 above was even more pronounced in the mismatching condition.

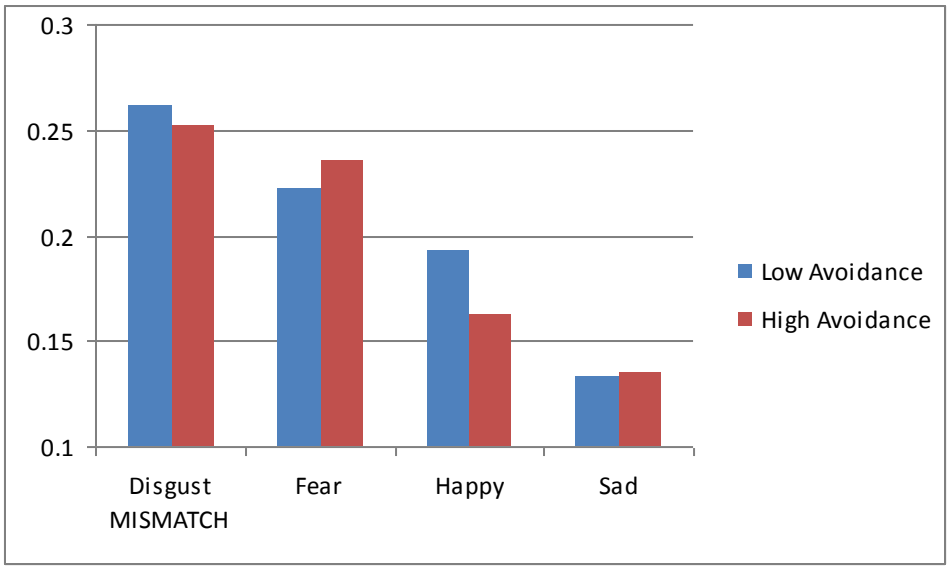

Figure 4.5. Proportion of fixations on the face within the mismatching context condition for each emotion for individuals higher and lower levels of avoidance

Follow up repeated measures ANOVAs were conducted to further explore the nature of the marginally-significant Context x Emotion x EN 3-way interaction. We ran 3 (within-subjects context match vs. mismatch vs. neutral) x 4 (PTSD symptom factors: re-experiencing vs. avoidance vs. EN vs. hyperarousal) repeated measures ANOVAS for each emotion separately. For happy faces, there was a significant 2-way Context x EN interaction, $F=3.07$ (2,70), $p=.053$, eta2=.08, whereas the Context x EN interactions were not significant for any of the other emotions.

As can be seen in the Figure 4.6, for matching trials, individuals with higher levels of EN attended to the happy face more than did individuals with lower levels of EN, whereas for neutral trials, individuals with lower levels of EN attended to the happy face more than did individuals with higher levels of EN. For mismatching conditions, there was almost no difference between individuals with higher and lower levels of EN in the proportion of fixations

on the face. Follow up post-hoc correlations did not reveal any significant associations between EN and fixations within any of the context conditions. However, when comparing the correlations (Meng, Rosenthal, & Rubin, 1992) there was a significant difference between the correlation for EN and fixations in matching contexts for happy faces compared to the correlation for EN and fixations in neutral contexts for happy faces, $z = -1.90$, $p = .03$.

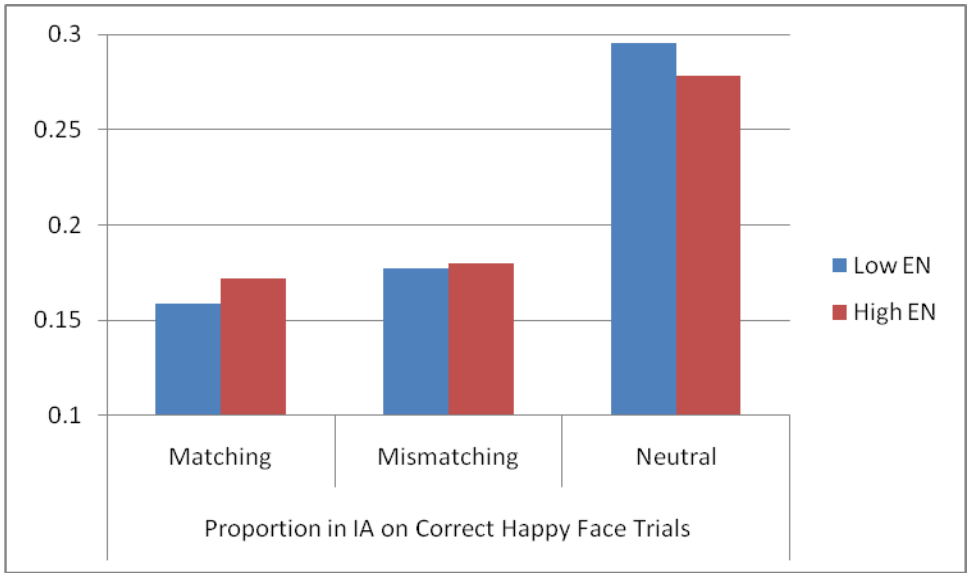

Figure 4.6. Proportion of fixations on happy faces for each context condition for individuals with higher and lower levels of EN

To examine the impact of context on the accuracy of facial affect recognition (and to potentially replicate findings from our previous research), we conducted a 3 (Within-Subjects Context Condition: match vs. mismatch vs. neutral) x 4 (Within-Subjects Emotion on the face: happy vs. sad vs. fear vs. disgust) x 4 (PTSD symptom clusters: re-experiencing vs. avoidance vs. emotional numbing vs. hyperarousal; these were treated as continuous between-subjects variables) repeated measures analysis of variance. There were no significant interactions, which was not consistent with previous findings.

Discussion

We utilized eyetracking with a contextual facial affect recognition task (the CRAFT) to explore the association between emotional processing and PTSD symptoms. We found that each of the four PTSD symptom factors were differentially related to aspects of emotional processing, and that individuals with higher and lower levels of PTSD symptoms showed different fixation patterns across contexts and emotions. For example, we found that individuals with higher levels of hyperarousal spent less time looking at the face and more time looking at the context than did individuals with lower levels of hyperarousal. This difference was especially pronounced for neutral contexts. One possible explanation for this finding is that, characteristic of hyperarousal symptoms, individuals high in hyperarousal are constantly scanning the background context checking for potential threat cues. Once they have accurately identified the emotion of the face and recognize that it is not threatening, it is possible that they do not spend any additional time staring at the face because the face does not provide them with any additional information about the situation. An alternative potential explanation is that individuals with higher levels of hyperarousal focus on what is least emotionally arousing. For example, the faces may be more arousing than much of the background, and for neutral contexts, the background is substantially less arousing than the emotional facial expressions.

We found that individuals with higher levels of re-experiencing spent less time fixating on negative faces than did individuals with lower levels of re-experiencing. In contrast, there was very little difference in fixations on happy faces between individuals with higher and lower levels of re-experiencing. Thus, individuals with elevated levels of re-experiencing seem to be sensitive to negative faces. One possible explanation for this finding is that the negative facial expressions act as a trigger causing the individual to re-experience negative thoughts, feelings,

and emotions. By fixating on the background contexts, they are avoiding the negative triggers. Also, because happy faces would not be expected to be threatening or to trigger any negative memories or emotions, individuals with higher levels of re-experiencing would not direct their attention away from them.

Whereas re-experiencing was found to be associated with all unpleasant faces, avoidance was associated with a heightened sensitivity to only fear faces. Specifically, we found that individuals with higher levels of avoidance fixated on fear faces for a higher proportion of the time compared to individuals with lower levels of avoidance. One possible explanation for this pattern of fixations is that fear faces have the most threat value because they are associated with fear experiences. Therefore, individuals with higher levels of avoidance are more likely to fixate for longer periods of time on fear faces since they are the most fear relevant. This would also explain why this pattern of responding is more prominent during the mismatching contexts. During mismatching trials for fear faces, none of the context images include fear. Consequently, in such trials the fear faces are the most relevant fear information. In other words, when only non-fear contexts and fear face are present, the fear face has a much higher threat value, which is why individuals with higher levels of avoidance are particularly likely to attend to the faces.

We also found that on matching context trials individuals with higher levels of EN tended to fixate on happy faces more than did individuals with lower levels of EN, whereas for neutral trials, individuals with lower levels of EN fixated on the happy faces more than did individuals with higher levels of EN. One possible explanation is that individuals with higher levels of EN are less interested in and less attentive to pleasant emotional information (as has been suggested by Litz et al., 1997). Whereas individuals with lower levels of EN tend to fixate on whatever is most pleasant because they are especially interested in and attentive to pleasant information, the

same is not true for individuals with higher levels of EN. Specifically, for neutral context conditions, the only pleasant emotional information is the face, and therefore, individuals with lower levels of EN tend to fixate on the face more than do individuals with higher levels of EN. Individuals with higher levels of EN are not particularly interested in the pleasant information, and therefore do not tend to fixate on the face (the only source of pleasant information for neutral trials with happy faces). In matching context conditions, there are happy faces as well as pleasant context backgrounds. Since the background is especially pleasant, probably more than the faces, individuals with lower levels of EN will devote less time to the faces and more time to the pleasant context, whereas individuals with higher levels of EN (compared to individuals with lower levels of EN) pay more attention to the happy faces and less attention to the context (since they are not drawn to the emotional stimulus with the most pleasant emotional information).

This study did not replicate our previous finding that individuals with higher levels of EN were more affected by the emotional context than individuals with lower levels of EN (Chapter 3). In fact, we did not find any relation between PTSD symptoms and accuracy rates. One possible explanation is that in this study we changed an important aspect of the CRAFT. In our previous research, the face appeared on the screen until the individual made the forced choice decision pressing a key to indicate which emotion was on the face. The CRAFT had to be adapted for use with the eyetracker; the face/context image was shown on the screen for 5 seconds, and then a second screen was shown with the emotion choices. Also, in between trials, participants viewed a screen with a fixation cross instead of the next trial immediately appearing. It is possible that the null results regarding accuracy varying as a function of PTSD symptoms and context was a result of individuals having a much longer time period to view the face and the background context image before making a decision. It appears that having more time to make a

judgment had a significant impact on accuracy rates overall, as evidenced by much higher accuracy rates in this study (78 % across emotions and contexts) compared to the previous two studies using the CRAFT (68 % and 69 % in Chapters 2 and 3, respectively). This change in the task is also why we were unable to examine reaction time.

The results of the current study provide additional evidence that PTSD symptoms are associated with the processing of emotional information, suggesting that it is important to examine individual symptoms of PTSD rather than just examining PTSD as a whole. It will be important for future research to more thoroughly explore the specific mechanisms that underlie the associations between PTSD symptoms and emotional processing. One limitation of the current research is that we have only begun to scratch the surface examining scanning and fixation patterns. For instance, future research should examine: (1) fixation duration to face (how long they look at a particular part of the face); (2) fixation duration to background image (how long they look at the total background or portions of the background – how long do they fixate on the gun in the picture vs. the hand holding the gun, for example); and (3) number of saccades/eye movements back and forth between looking at the face and looking at the background context.

For facial affect recognition methodologies, future research using eye-tracking should examine RT to see if scanning and fixation patterns differ when an individual has to make a "split-second" real-time decision. Additional research strategies, such as measuring event related potentials while participants are processing emotional information, are also likely to provide clues to the mechanisms underlying the associations between individual PTSD symptoms and emotional processing. It will also be important to examine how different types of traumas may lead to different scanning and fixation patterns as well. This research has begun to shed light on

the relations between individual PTSD symptom factors and emotional processing. Future research is warranted to eventually help us develop conceptual models of PTSD and PTSD symptoms and their associations with emotional processing.

Chapter 5

General Discussion

Over two-thirds of the population has been exposed to at least one traumatic life event during their lifetime (Resnick et al., 1993; Breslau, 2009), and approximately 10% of these individuals develop PTSD (Breslau, 2009). My research, which has been examining emotional processing and its relation to PTSD, is distinct in two ways. First, I have examined individual symptom factors of PTSD, not just PTSD as a whole. Second, I have examined how the relation between PTSD symptom factors and the processing of emotional stimuli is affected by other emotional information (i.e., non-target emotional stimuli) presented in conjunction with, or immediately preceding, the target emotional stimuli.

It will be important to further unpack the nature of PTSD symptoms, and what other sequelae of trauma should be included beyond the current 17 symptoms listed in the DSM-IV-TR (APA, 1994) (e.g., dissociation, guilt or shame reactions, etc.). Knowing that each individual experiences a different combination of symptoms post-trauma, it is hard to believe that there are only 17 symptoms that define PTSD and that are sufficient to optimally measure PTSD. As additional symptoms emerge, it will be important to develop new factor models of PTSD. One current issue is that the EN symptom factor is composed of five symptoms (restricted affect, diminished interest, detachment, foreshortened future, and amnesia), but two of those symptoms are not directly related to emotion (foreshortened future and amnesia). As new symptoms emerge, it will be important to develop new conceptualizations of symptom factors and structures.

In addition to identifying other sequelae of trauma, a related area warranting future inquiry is the measurement of PTSD symptoms. The majority of researchers use standard questionnaires and self-report measures to assess PTSD symptoms. The Clinician Administered PTSD Scale (CAPS; Blake et al., 1995; Weathers, Keane, & Davidson, 2001; Weathers, Ruscio, & Keane, 1999) has proven to be a useful interview tool, but as has been suggested in the literature (Palmieri, Weathers, Difede, & King, 2007b), some individuals are not comfortable disclosing personal information about their traumas to researchers whom they do not know and are more honest on self-report questionnaires. This was one suggested possibility for why different factor models emerged when different types of measurement were used (Palmieri, Weathers, Difede, & King, 2007b). Currently, the self-report questionnaire that is most commonly used is the PTSD checklist (PCL; Weathers, Litz, Herman, Huska, & Keane, 1993). This measure asks participants to indicate how frequently they experience symptoms, and severity is inferred from frequency. This can present a problem because an individual may have unwanted memories daily, for example, but these memories are not extremely distressing. Therefore, development of more thorough self-report measures is needed.

Additional work is also needed regarding the measurement of trauma and PTSD Criterion A. The current most commonly used self-report measure for identifying traumatic life experiences, the Life Events Checklist (LEC; Gray, Litz, Hsu, & Lombardo, 2004), gets an accurate account of whether or not someone experienced the 17 most common traumatic life events. However, no information about the details of the traumatic event is obtained. For example, an individual may endorse experiencing a natural disaster because a tornado passed by 10 miles away, which most individuals would not consider being traumatic. Similarly, someone may have endorsed being in a transportation accident after having a mild fender bender which

most individuals would not consider being traumatic. Also, if someone chooses item 17, "other", we have no idea what type of event occurred that the individual considered traumatic. According to the DSM-IV-TR (APA, 1994) in order for an event to be classified as traumatic and therefore meet qualification criteria for PTSD Criterion A, that event must have included a serious threat of death, injury or threat to one's physical integrity, and the event must have resulted in emotional responses of helplessness, horror, or intense fear. It is important to measure Criterion A directly instead of assuming that when someone endorses having experienced a stressful life event that it actually met criteria to qualify as traumatic (and would meet the qualifications of Criterion A). It is possible that when conducting research including individuals who have had direct exposure to traumatic life events, we are actually including individuals who did not experience an event that would be classified as genuinely traumatic according to DSM-IV-TR standards. Such inclusion can add "noise" to the data.

Apart from examining trauma and PTSD symptoms, the processing of emotional information in its own right is another area that still warrants further research and exploration. There is much room to develop new ways of measuring emotional processing beyond the Stroop task and the CRAFT. For example, it will be useful to not only use static faces but to also utilize dynamic (moving) faces when using facial affect recognition to study emotional processing. However, it is important to note that research on emotional processing must expand beyond just individual words and faces. Along with using different types of stimuli, it will also be important to continue to attend to differences in emotional processing when examining the effect of non-target emotional stimuli on the processing of target emotional stimuli. Also, researchers should be open to examining a variety of dependent variables such as EEG and fMRI, not just accuracy

and RT. It is quite possible that differences will emerge when examining emotional processing beyond just accuracy and response times.

Given that the judgment of the emotion on the face is *not* made independently of contextual information, future research needs to explore how and why this happens. For example, it will be important to determine whether the contextual information affects the perceiver's mood which in turn affects the judgments. Even if the impact of contextual information on facial affect recognition is mediated by mood, the effects of mood on facial affect recognition are undoubtedly mediated by cognitive processes. Thus, it will also be critical to determine whether contextual information directly or indirectly (via mood) alters: (a) which information on the face is attended to, how quickly, and for how long; and/or (b) how the information on the face, once attended to, is utilized; and/or (c) the process by which the judgment is made.

Additionally, it will be important for future research to explore the different facets/dimensions of context to see how different types of context affect the processing of emotional information differently. For example, future research should continue to explore how visual contextual information can affect judgments differently than olfactory or auditory contextual information. It will also be important to explore how other aspects of context, such as its timing (e.g., context presented prior to the face vs. context presented concurrently, as was the case in the present research) and relevance (e.g., directly connected to the face being judged vs. independent of the face being judged, as was the case in the present research), affect facial affect recognition.

When examining the processing of emotional information and how it is associated with PTSD symptoms, it will be important to examine how deficits and/or biases can be episodic

compared to chronic. For example, as was suggested by Litz (1992), it is possible that different disturbances in emotional processing could be evident when a fear network is activated than when it is not activated. It will be important for future research to better understand how emotional processing disturbances may change depending on the situation, context, level of stress, or emotion the individual is experiencing.

It will also be important to better understand directions of causality. For instance, is it that an individual who is exposed to a traumatic life event processes emotional information differently because she developed PTSD symptoms, or is it her difference in processing emotional information that made her more susceptible to develop PTSD symptoms in the first place? If someone is prone to feelings of guilt and shame, are they more likely to develop EN to numb the feeling or avoidance symptoms to avoid such negative emotions, or does EN or avoidance maintain such emotional responses?

As research continues to examine individual symptoms of PTSD, as well as emotional processing, it will be important for researchers to develop theoretically driven models of PTSD as well as emotional processing. Based on our findings that the processing of target emotional information by individuals with higher and lower levels of EN is differentially affected by the presentation of non-target emotional information, we propose a new model of emotional processing and EN (described below and illustrated in Figure 5.1).

We have found that the impact of non-target emotional information on the processing of target emotional information is either enhanced or diminished among individuals with elevated levels of EN. Past research has provided evidence of other individual differences that are associated with patterns of performance that are in opposite directions depending on task characteristics. For example, Altamirano, Miyake and Whitmer (2010) found that rumination is

associated with worse performance on a task that involves set-shifting but better performance on a task that requires "goal maintenance." Both were thought to reflect the same underlying disturbance - "mental inflexibility." Along the same lines, Kerns and Berenbaum (2010) found that emotionally overwhelmed individuals with high current arousal were either over- or under-influenced by affective information depending on the evaluative nature of the task. Kerns and Berenbaum (2010) proposed that both sets of findings could be attributed to the attempts of overwhelmed individuals to counteract the influence of affective information.

I propose that individuals with elevated levels of EN are extremely intolerant of emotional information (i.e., it makes them very uncomfortable). When non-target emotional information is irrelevant, they can successfully ignore, or quickly complete the processing of, the emotional information (as seen in the WPT task in Milanak and Berenbaum, 2009). In such cases, the influence of non-target emotional information is diminished. However, once the level of emotional relevance reaches a particular threshold, individuals with higher levels of EN are no longer able to successfully ignore, or quickly complete the processing of. the emotional information. Under such circumstances, given their sensitivity to, and intolerance of, emotional information in general, the impact of that emotional information is enhanced (as seen in Study 2). In other words, EN is associated with a difference in the impact of non-target emotional information on processing target emotional information depending on the level of emotional relevance of the non-target stimulus. This proposal is illustrated in Figure 5.1. As can be seen in Figure 5.1, the slope of the relation between emotional relevance of the non-target emotional stimulus and the impact of the non-target emotional stimulus on the processing of target emotional stimuli is steeper for individuals with higher levels of EN than for individuals with lower levels of EN. In other words, the increased sensitivity of individuals with elevated levels

of EN to emotional information is represented by their having a steeper slope, or gradient. Consequently, when the emotional relevance of the non-target emotional stimulus is quite low, individuals with elevated levels of EN will be less strongly affected than will individuals with lower levels of EN. In contrast, when the emotional relevance of the non-target emotional stimulus is high, individuals with elevated levels of EN will be more strongly affected than will individuals with lower levels of EN.

Figure 5.1. The impact of non-target emotional information on the processing of target emotional information

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