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Olfactory Identification Dysfunction Associated with Posttraumatic Stress Disorder and Big Five Personality Traits

by Brittany Bowman

A Doctoral Dissertation

submitted in partial fulfillment of the requirements

for the degree of

Doctor of Philosophy in the Department of Psychology

Idaho State University

Summer 2015

To the Graduate Faculty:

The members of the committee appointed to examine the dissertation of Brittany Bowman find it satisfactory and recommend that it be accepted.

_____ Tera Letzring, Ph.D., Major Advisor

_____ Peter Vik, Ph.D., Committee Member

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October 30, 2013

Brittany Bowman
Stop 8112
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RE: Your application dated 10/28/2013 regarding study number 3965R: Olfactory Identification Dysfunction Associated with Post-traumatic Stress Disorder and Big Five Personality Traits

Dear Ms. Bowman:

I have reviewed your request for approval of the advertisement/ recruitment plan for the study listed above. This type of request is eligible for expedited review under FDA and NDHHS (OHRP) regulations.

This is to confirm that your plan was approved.

You are granted permission to use your recruitment plan and any publicity materials described in your application effective immediately.

Please note that any changes to the study as approved must be promptly reported and approved. Some changes may be approved by expedited review; others require full board review. Contact Patricia Hunter (208-282-2179; fax 208-282-4723; email: humsubj@isu.edu) if you have any questions or require further information.

Sincerely,

Ralph Baergen, PhD, MPH, CIP
Human Subjects Chair

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Abstract

Rates of traumatic exposure among undergraduate college students is estimated to be between 67% and 85% (Frazier et al., 2009; Moser, Hajack, Simons, & Foa, 2007), while an estimated 8% to 9% meet diagnostic criteria for Posttraumatic Stress Disorder (PTSD; Frazier et al., 2009; Read, Ouimet, White, Colder, Farrow, 2011). Dysfunction in the orbitofrontal cortex (OFC) has been associated with combat-related PTSD (e.g., Dileo et al., 2007), but has not been explored in the general population. OFC dysfunction has also been associated with two personality traits: neuroticism and extraversion. The current study sought to explore the relationship between personality, PTSD, and OFC functioning as measured by an olfactory identification (OI) task. Hypotheses were: 1) participants high on neuroticism would perform worse on the OI task than participants low on neuroticism and those high on extraversion would perform better than those low on extraversion; 2) participants with higher PTSD symptoms would exhibit poorer performance on the OI task than participants with lower PTSD symptoms; 3) there would be an interaction between personality traits and PTSD in the prediction of OI scores. One hundred and seven undergraduate college students completed clinical measures of PTSD, depression, anxiety, and mania, and an olfactory identification task. Hierarchical regression analyses revealed that neither neuroticism nor extraversion significantly predicted OI. Hierarchical regression analyses also revealed that total PTSD symptoms did not significantly predict OI. However, exploratory analyses indicated that the re-experiencing symptom cluster of PTSD had a significantly negative relationship with OI (β = -.20, p = .04). Lastly, results demonstrated that neuroticism, extraversion, and total PTSD symptoms did not significantly interact to predict OI. Exploratory analyses were conducted to explore the relationship between other personality traits/facets and OI as

well as between personality traits/facets and PTSD symptom clusters. These results provide important insights into potential prevention/intervention strategies for PTSD.

Chapter I: Introduction

Olfactory Identification Dysfunction Associated with Posttraumatic Stress Disorder and Big Five Personality Traits

Rates of Posttraumatic Stress Disorder (PTSD) among college students are estimated to be 8-9% (Frazier et al., 2009; Read, Ouimet, White, Colder, Farrow, 2011). This is similar to the estimated 8% prevalence of PTSD within community samples (APA, 2000). Lifetime prevalence of exposure to traumatic experiences among undergraduate college students is estimated to be between 67% and 85% (Frazier et al., 2009; Moser, Hajack, Simons, & Foa, 2007). This is compared to the lifetime rate of exposure to traumatic events in the general population estimated to be 21% (Perrin, Vandeleur, Castelao, Rothen, Glaus, 2014). Therefore, undergraduate college students report high rates of exposure to traumatic events throughout their tenure in college as compared to the rates reported by the general population. However, these data also indicate that the majority of individuals who are exposed to traumatic events do not go on to develop PTSD. The discrepancy between the rate of trauma exposure and the rate of PTSD development among college students suggests the need for further research geared towards the identification of the determinants of PTSD development in order to inform prevention and/or intervention strategies.

It has long been recognized that a relatively small percentage of individuals who experience a traumatic event go on to develop PTSD. Research has identified several factors that are associated with PTSD development following trauma exposure, including gender, type of traumatic exposure, and preexisting psychopathology (Brewin, Andrews, & Valentine, 2000; Ozer, Best, Lipsey, & Weiss, 2008; Perrin et al., 2014). Other, more

dynamic factors have also been identified, including perceived social support (Brewin, Andrews, & Valentine, 2000; Ozer, Best, Lipsey, & Weiss, 2008), global self-esteem (Adams & Boscarino, 2006; Sutker, Corrigan, Sundgaard-Riise, Uddo, & Allain, 2002), "hardiness" (Whealin, Ruzek, Southwick, 2008)**,** and coping strategies (Perrin et al., 2014; Schnider, Elhai, & Gray, 2007). One weakness of the PTSD literature is that there is very little translational research between different disciplines within psychology. As a result, researchers within the various subdisciplines of psychology often appear to be studying similar constructs under different names. This makes it difficult to integrate research findings across disciplines and to draw conclusions from this research. Translational research is critical in its potential to integrate research findings across disciplines and to reveal possible explanations for why one person develops PTSD upon exposure to a traumatic event while another person does not. Personality research, in particular, may be able to bridge the gap between subdisciplines of psychology, and may provide interesting insights into the development and maintenance of PTSD.

Personality is a central component of the human experience. It influences a person's perception of the environment and it shapes the manner in which individuals behave in their environment. Therefore, personality may have a greater impact on the development, maintenance, and topography of PTSD symptoms than has been previously hypothesized. Although research abounds that relates the Big Five personality traits to various pathological states, both in terms of mental and physical illness (e.g. Lonnqvist et al., 2009), very little empirical study has been devoted to linking the Big Five personality traits to PTSD in particular. Several studies have found a relationship between Neuroticism and PTSD such that higher levels of neuroticism were associated with a

greater likelihood of being diagnosed with PTSD (Cox, MacPherson, Enns, & McWilliams, 2004; Perrin et al., 2014). However, these studies have only included very brief assessments of neuroticism, and they have not included assessments of the other four personality traits. Assessment of all five distinct traits is necessary in order to fully understand the nature of the relationship between personality and PTSD. Further, research has not extended beyond traits to include personality facets, which contain more precise descriptive information and may have more predictive potential than do broader traits. Additionally, research has not yet attempted to explore potential relationships between personality traits, personality facets, and specific PTSD symptom clusters. Exploration of the relationship between personality traits, personality facets, and specific PTSD symptom clusters is important in that it may provide important information about the heterogeneity of symptom presentation, symptom development and/or maintenance, and intervention strategies.

Although the full nature of the relationship between PTSD and personality has not yet been thoroughly explored, factors like perceived social support, coping strategies, and "hardiness" have been found to significantly predict the development of PTSD. However, research does not address the issue of what impacts these factors. It is possible that personality traits are the superordinate constructs that impact some of the factors found to predict PTSD development. For example, low perceived social support was found to be the strongest predictor of PTSD development in two meta-analyses (Brewin, Andrews, & Valentine, 2000; Ozer, Best, Lipsey, & Weiss, 2008). It would make sense that extraversion may play a role in the extent to which a person seeks to actively develop social relationships, which would then impact perceived social support. Personality

theory could therefore hold valuable information regarding vulnerability to the development of PTSD as well as potential prevention or intervention strategies for the disorder.

Neurological factors are also thought to be associated with the development and maintenance of PTSD symptoms. Exposure to extreme stress has been hypothesized to impact brain regions such as the hippocampus, amygdala, and prefrontal cortex (Brewin, 2001a; 2001b), which are critical to attention, encoding, and memory storage. The orbitofrontal cortex (OFC) is one region within the prefrontal cortex that has been hypothesized to be involved in PTSD. The OFC is thought to play a role in the extinction of learned fear responses (Kühn, Schubert, Gallinat, 2011) and has recently emerged from research on Vietnam War veterans as a prefrontal region that is relevant to both personality characteristics and traumatic symptoms (e.g., Dileo et al., 2007; Vasterling, Brailey, & Sutker, 2000). The specific aims of this study are therefore to examine the (a) relationship between personality traits and OFC functioning (as measured by olfactory sensitivity), (b) relationship between PTSD symptoms and OFC functioning, (c) interaction of PTSD symptoms and personality to predict OFC functioning, and (d) to explore potential relationships between personality traits or facets with specific PTSD symptom clusters. This study will utilize an undergraduate college student population. One important rationale for using college students is that the only research utilizing olfactory identification tasks to examine the role of the OFC in the development and/or maintenance of PTSD symptoms has used a Vietnam War Veteran sample. These findings therefore have the potential to extend findings related to OFC functioning to a civilian population. This study will also begin to address a gap in the literature regarding

the absence of translational research between clinical and personality psychology. Specifically, the identification of a relationship between personality traits/facets and PTSD symptom clusters will be a novel contribution to the field.

Posttraumatic Stress Disorder (PTSD)

What is PTSD?

The fourth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV; American Psychiatric Association [APA], 2000) classified posttraumatic stress disorder (PTSD) as an anxiety disorder that occurs after an individual is exposed to a traumatic stressor in which 1) the person experienced, witnessed, or was confronted with an event that involved actual or threatened death or serious injury or a threat to the physical integrity of self or others and 2) the response to the event involved intense fear, helplessness, or horror. The likelihood of developing PTSD and the severity of the disorder, if present, are partially determined by a number of factors. The disorder may be especially severe or long-lasting if the traumatic event was of human design (e.g., torture, rape) versus a natural disaster (APA, 2000). The likelihood of developing the disorder also increases as the intensity of and physical proximity to the stressor increases (APA, 2000).

The core issue of PTSD is that the experience of and information related to the traumatic event cannot be integrated into autobiographical memory (van der Kolk & McFarlane, 1996). The hallmark symptoms of PTSD include persistently re-experiencing the traumatic event, persistent avoidance of stimuli associated with the traumatic event, numbing of general responsiveness, and persistent symptoms of increased arousal (APA, 2000). These symptoms must have been present for more than one month and they must

cause clinically significant distress or impairment in an important area of functioning. These four symptom clusters include several sub-characteristics that are elucidated below.

Re-experiencing.

Re-experiencing symptomology is one of the primary groups of symptoms necessary for a diagnosis of PTSD. Individuals with PTSD may experience recurrent and intrusive distressing recollections of the event, they may experience recurrent nightmares related to the trauma, and they may have flashbacks whereby they feel as if the traumatic event is recurring (APA, 2000). Also present is intense psychological distress at exposure to internal or external cues that symbolize or resemble an aspect of the traumatic event, and physiological reactivity upon exposure to said cues (APA, 2000). As a result of an inability to integrate the traumatic memory, the memory remains fragmented and often primarily consists of intense emotions or somatosensory impressions (van der Kolk & McFArlane, 1996). This fragmented memory is in contrast to a coherent narrative that is appropriately placed within a historical context, which is the form that most autobiographical memories assume (van der Kolk & McFarlane, 1996). These fragments (e.g., images, physical sensations) are particularly likely to be repeatedly re-experienced when the individual encounters a cue associated with the event. Such cues can include any external or internal stimulus that was present during or is somehow associated with the traumatic event (Brewin, 2001a; 2001b). For example, an odor, a sound, or an emotion can all serve as triggers to re-experiencing symptoms without the individual's awareness of the trigger. Such triggers or cues serve to make the world perceived to be an increasingly dangerous place that will unpredictably activate symptoms of re-

experiencing the traumatic event. Therefore, the trauma remains a continuous and present threat rather than a negative experience that belongs safely in the past (van der Kolk & McFarlane, 1996).

Avoidance.

Avoidance is the second primary symptom group necessary for a diagnosis of PTSD. Individuals with PTSD often organize their lives around avoiding stimuli associated with the trauma for fear that those stimuli will trigger the intrusive recollections discussed above (van der Kolk & McFarlane, 1996). They avoid thoughts, feelings or conversations associated with the trauma; they avoid activities, places, or people that bring about recollections of the trauma; and they may be unable to recall important aspects of the trauma (APA, 2000). This avoidant behavior gradually generalizes to a wide variety of situations and stimuli until the scope of these individuals' lives is greatly reduced (van der Kolk & McFArlane, 1996).

Numbing.

Numbing is grouped together with the avoidance symptoms in the DSM diagnostic criteria, and is therefore part of the second primary symptom group. Numbing, however, is different from the active avoidance described above, and it likely has a different underlying pathophysiology (van der Kolk & McFarlane, 1996). Individuals with PTSD often experience generalized numbing to a wide variety of emotional aspects of life (van der Kolk & McFarlane, 1996). They often experience markedly diminished interest or participation in activities, experience a feeling of detachment or estrangement from others, have a restricted range of affect, and a sense of a foreshortened future (APA, 2000). Some individuals use substances to numb their emotional awareness while others

develop dissociative symptoms to keep unpleasant memories at bay (van der Kolk & McFarlane, 1996). As a result, these individuals experience a progressive decline such that any emotional stimulation, whether positive or negative, leads to further detachment (van der Kolk & McFarlane, 1996). This inability to process emotional stimuli likely leads to increased physiological arousal and psychosomatic problems.

Hyperarousal.

Hyperarousal is the third symptom cluster necessary for a PTSD diagnosis. Despite the emotional numbing individuals with PTSD experience, they remain highly vigilant and often react to environmental stimuli as if those experiences represent continuing threats (van der Kolk & McFarlane, 1996). Arousal symptoms include difficulty falling or staying asleep, irritability or outbursts of anger, difficulty concentrating, hypervigilance, and an exaggerated startle response (APA, 2000). Individuals with PTSD often experience intense negative emotions in response to sometimes minor environmental stimuli without even realizing what it is that upset them (van der Kolk & McFarlane, 2000). This hyperarousal towards environmental stimuli gradually begins to generalize so that the individual is unable to predict when a stimulus will trigger an intense physiological response (van der Kolk & McFarlane, 2000).

The development and maintenance of PTSD symptoms involves extensive fear conditioning, a process that has strong neurological associations (Brewin, 2001a; 2001b). PTSD is associated with a dysfunctional neurocircuit. The following section reviews potential neurological correlates.

Neurological processes.

One method of assessing OFC dysfunction is through the use of high-resolution structural magnetic resonance imaging (MRI) scans that allow researchers to measure cortical thickness. Cortical thickness is a term used to describe the combined thickness of the layers of the cerebral cortex (Fischl & Dale, 2000). The precise manner in which cortical thickness is measured is beyond the scope of this paper and is described in detail elsewhere (e.g., Dale, Fischl, Sereno, 1999). Of note, research is ambiguous regarding the provision of an explanation about how cortical thickness translates to functioning. Most research appears to support the idea that greater cortical volume translates to greater functionality under the premise that greater volume is the result of a greater population of neurons that can then be more influential than a smaller population of neurons (Boyke, Driemeyer, Gaser, Buchel, & May, 2008; DeYoung, Hirsh, Shane, Papademetris, Rajeevan et al., 2010; Walhovd, Fjell, Reinvang, Lundervold, Fischl et al., 2004). However, other research suggests that reduced cortical thickness may indicate increased efficiency of a particular brain area, and therefore improved functionality (DeYoung et al., 2010). Similarly, some research suggests that increased cortical thickness may be associated with various psychological disorders (e.g., Rauch et al., 2004). Therefore, there is not a one-to-one correlation between neurological structure and function. However, it does appear that variability in structure contributes to variability in function and may therefore provide important information related to neurological functioning.

OFC dysfunction has also been assessed through the use of functional MRI (fMRI). fMRI allows researchers to measure activity in a particular brain region by measuring changes in blood oxygen levels (Shang et al., 2014). However, there are

several limitations to the interpretation of fMRI data. One limitation is that fMRI measures blood flow, rather than actual neuronal activity (Bandettini, 2009**).** Although research has concluded that fMRI scans provide a reliable and valid measure of neuronal activity, ambiguity related to the manner in which blood oxygen level changes translate to functioning remains (Bandettini, 2009). Another limitation is that fMRI scans are not able to differentiate between excitatory and inhibitory activity (Bandettini, 2009). Increased blood flow may represent excitatory activity in a particular brain region; however, it could also mean that that particular brain area is being inhibited - a process that may also require blood flow. Although research has not yet provided a resolution for these problems, research utilizing structural and functional MRI to explore the neurological correlates of PTSD and other psychological phenomena remains a valuable endeavor and contributes to greater understanding of these issues.

The major neurological process underlying PTSD is thought to be a dysfunctional circuit between the frontal lobes and the limbic system. Research suggests that the symptom presentation in PTSD primarily results from a hypersensitive amygdala, and frontal lobes that are incapable of diffusing amygdala activation when the threat stimulus is not actually a threat (Brewin, 2001a; 2001b; Cardenas, 2011). Additionally, hippocampal dysfunction leads to memory deficits and difficulties identifying safe contexts (Brewin, 2001a; 2001b; Cardenas, 2011). In individuals without PTSD (or other prefrontal dysfunction), the frontal lobes have adequate control over the amygdala and can quickly dampen perceived threat responses activated by a benign environmental stimulus. In individuals with PTSD, however, the frontal lobes have diminished control, leaving afflicted individuals victim to their hyperresponsive amygdala (Brewin, 2001a;

2001b; Cardenas, 2011). Within the prefrontal cortex of individuals with PTSD, several studies have concluded that more localized dysfunction in the orbitofrontal cortex is largely responsible for the symptom presentation of PTSD (Dileo et al., 2007; Vasterling et al., 2000). One study has even suggested that orbitofrontal dysfunction often precedes the development of PTSD, thereby serving as a risk factor for PTSD development (Kühn et al., 2011).

Orbitofrontal cortex and PTSD.

The orbitofrontal cortex (OFC) is located within the prefrontal cortex and includes several subregions, all with different patterns of connections. One region connects to the amygdala and hypothalamus, while another region connects with the medial temporal cortical areas that are involved in recognition memory (Kolb & Whishaw, 2003). The OFC plays a role in various processes of reward and self-regulation (Spinella & Miley, 2004). Specifically, the OFC is involved in coding the value of rewards (De Young, 2010), and inhibiting impulsive behavior and making explicit judgments about others' trustworthiness (Kolb & Whishaw, 2003). Lesions to the OFC result in marked changes to personality and social conduct including behavioral disinhibition, jocularity, impulsivity, reduced autonomy, insensitivity to punishment, and mood lability (Malloy, Bihrle, & Duffy, 1993). Damage to the OFC also reduces decision-making ability, impairs judgment, and leads to short-sighted and irresponsible behavior, and anosmia - the inability to perceive odor (Eslinger & Damasio, 1985; Malloy et al., 1993). Further, individuals with damage to the OFC exhibit difficulties with the learning and reversal of reward associations (Berlin, Rolls, & Kischka, 2004; Rolls, Hornak, Wade, & McGrath, 1994). The research cumulatively suggests, therefore,

that OFC damage results in an overall deficit in directing behavior based on reinforcement contingencies.

As is apparent from the discussion above, the OFC is responsible for a wide variety of important behaviors. As it pertains to PTSD, research suggests that the OFC plays an important role in modulating PTSD symptoms (Kühn et al., 2011; Milad et al., 2005; Milad et al., 2008). Specifically, the OFC is thought to be largely involved in the process of extinguishing a fear response (Kühn et al., 2011; Milad et al., 2005**;** Rauch et al., 2005). Fear conditioning takes place via classical conditioning whereby a neutral stimulus (conditioned stimulus, CS) is paired with an aversive, fearful stimulus (unconditioned stimulus, UCS) (Pavlov, 1927). Thereafter, the CS becomes a feared stimulus because of its association with the UCS. Fear extinction occurs when new learning takes place that determines that the CS no longer predicts the UCS and the conditioned response (CR) is therefore inhibited.

Research suggests that the OFC is involved in fear extinction based on functional Magnetic Resonance Imaging (fMRI) studies that have found a relationship between the cortical thickness of the medial OFC (mOFC) and retention of the extinction memory (Milad et al., 2005; Rauch et al., 2005). Therefore, when a CS elicits an initial fear response, the OFC is likely involved in dampening the amygdala's response based on new learning that the CS no longer predicts danger. This process does not appear to operate effectively in individuals with PTSD. Individuals with PTSD have been found to have deficits in fear extinction recall, or the ability to retrieve the newly learned information that determined that the feared stimulus no longer predicts danger (Milad et al., 2008). Additionally, research on patients with OFC lesions concluded that OFC

damage results in failure to change behaviors in response to changing reinforcers and/or punishers rather than a failure to learn the stimulus-reinforcement relationship (Berlin et al., 2004). The result is that individuals with dysfunction in the OFC are unable to dampen the emotional response that arises when they encounter a CS. The OFC, therefore, plays a critical role in facilitating the human ability to redirect behavior based on new learning. When there is dysfunction in the OFC, as is hypothesized to exist in individuals with PTSD, symptoms of PTSD appear to be more likely to develop and more likely to be maintained over the course of time due to a reduced ability to retain extinction memory.

Research has demonstrated that individuals with combat-related PTSD exhibit OFC dysfunction (Dileo et al., 2008; Vasterling et al., 2000). Research exploring OFC dysfunction using structural MRI scans, has found lower volume bilaterally in the lateral OFC in individuals who have been exposed to combat-related trauma but do not meet criteria for PTSD (Eckart et al., 2011). Similarly, research has observed lower OFC volume in individuals with non-combat-related PTSD (Milad et al., 2005; Rauch et al., 2003; Rauch et al., 2005). Research also suggests that when exposed to trauma-related cues, the prefrontal cortex (PFC) in individuals with PTSD fails to activate when compared to the PFC of individuals who do not have PTSD (Bremner et al., 2004; Shin et al., 2004). Additionally, other research has demonstrated that individuals with PTSD tend to be deficient in behavioral extinction overall (Orr et al., 2000**).** Further, evidence was found to support the idea of a "building block effect," whereby the extent of traumatization moderated the amount of volume loss in the OFC: the more trauma the participant had experienced, the more severe the volume loss in the lateral OFC (Eckart

et al., 2011). Decreased volume in the medial OFC has also been associated with anxiety disorders in general (Bienvenu et al., 2001). Therefore, reduced volume in the OFC appears to be associated with PTSD (Dileo et al., 2008; Eckart et al., 2011).

Given the emerging evidence of the importance of the OFC in conditions like PTSD, it is important to develop non-invasive methods of measuring orbitofrontal dysfunction that can utilize larger sample sizes; because relatively intrusive imaging studies are expensive and tend to rely on small sample sizes. Olfactory identification tasks offer an alternative method of inferring OFC functioning that is becoming more frequently employed in the literature as a way to detect orbitofrontal dysfunction.

Olfactory identification tasks have been shown to be associated with OFC functioning. Research has demonstrated increased activity of the OFC during olfactory identification (OI) tasks, as well anosmia (the inability to perceive odor) in individuals with damage to the OFC (Savic, Bookheimer, Fried, & Engel, 1997; Savic & Gulyas, 2000). The right OFC is thought to be especially important in OI tasks (Kjelvik, Evensmoen, Brezova, Haberg, 2012). In addition to odor identification, the OFC plays a crucial role in judging the pleasantness of an odor (Dileo et al., 2008; Vasterling et al., 2000). OI tasks are therefore increasingly being used to detect OFC dysfunction in individuals with PTSD (Dileo et al., 2008; Vasterling, et al., 2000).

Dileo et al. (2008) used OI tasks to investigate OFC functioning in a group of 31 male Vietnam War veterans with a mean age of 58.23 years (SD = 2.56). They found that individuals with PTSD were significantly worse at identifying pleasant and unpleasant odors than controls that were age and gender-matched. Further, a double dissociation was found between PTSD participants and control participants: PTSD participants were worse

at identifying pleasant and unpleasant odors but were better at identifying neutral odors, whereas controls were better at identifying pleasant and unpleasant odors but were worse at identifying neutral odors. Additionally, no between-group differences were found on other cognitive tasks designed to assess dorsolateral prefrontal cortex, ventral prefrontal cortex, and medial temporal lobe functioning (Dileo et al., 2008).

Another study that utilized OI tasks to detect OFC dysfunction in individuals with PTSD was conducted by Vasterling et al. (2000). This study utilized 68 male Vietnam or Vietnam-era veterans. OI, executive functioning, and anterograde memory were assessed in three groups of participants: 1) Vietnam war-zone vets diagnosed with PTSD; 2) Vietnam war-zone vets without PTSD or other Axis I mental health disorders; 3) Vietnam-era veterans who did not serve in the war-zone and did not have PTSD or other Axis I mental health disorders. They found that veterans with PTSD performed more poorly on the OI task than war-zone deployed and non-deployed veterans without PTSD. The three groups did not differ on any other cognitive measures (Vasterling, Brailey, Sutker, 2000). Together, the results of these two studies provide evidence for more localized OFC dysfunction in the neurological processes underlying PTSD (Dileo et al., 2008; Vasterling et al., 2000).

Thus far the clinical presentation and neurological correlates of PTSD have been discussed. Another area meriting further research in terms of its potential impact on the maintenance and/or development of PTSD is personality theory. Personality, the enduring and stable aspect of ourselves, impacts the way in which we interact with our environment and the effect the environment has on us. It would make sense, therefore,

that personality may play a larger role in determining the course of mental health disorders than has previously been thought.

Big Five Personality Traits

What are the Big Five?

Decades of research, beginning with the lexical approach in the early 1930's (e.g., Allport & Odbert, 1936), has consistently yielded a five factor structure of personality. The lexical hypothesis posited that the most salient information regarding personality characteristics can be found in language, since people will have created words to describe the aspects of personality that are most socially relevant (Allport & Odbert, 1936). The lexical approach uncovered adjectives for several different levels of personality description. One of these levels consists of personality traits, which are the relatively enduring and generalized aspects of personality. Other levels include temporary states and moods, and evaluative judgments that can be made about a person (Allport & Odbert, 1936). Most current conceptualizations of personality fall within the first level of description: personality traits.

The Five Factor Model (FFM) adopts trait theory, which states that individuals can be characterized in terms of relatively enduring patterns of thought, action, and behavior, and that these patterns are relatively generalizable across different situations (John, Nauman, & Soto, 2008). Traits are neither too broad in that they are unable to distinguish between one person and another, nor are they too narrow in that they are unable to produce generalizable information (John et al., 2008). The five factors are neuroticism, extraversion, conscientiousness, agreeableness, and openness to experience.

Neuroticism is the general tendency to experience negative emotionality and sensitivity to punishment (John et al., 2008; Suchy, 2011). It includes feelings of anxiety, depression, and nervousness. Its opposite pole is emotional stability (Suchy, 2011). Extraversion is energy, enthusiasm, sociability, and sensitivity to reward (John et al., 2008; Suchy, 2011). It implies an energetic approach to the world and a tendency to experience positive emotions. Its opposite pole is introversion (Suchy, 2011). Conscientiousness is constraint or impulse control and includes the ability to engage in goal-directed behavior like delaying gratification in service to a long-term goal, thinking before acting, following rules or norms, and planning (John et al., 2008). Its opposite pole is impulsivity (John et al., 2008). Agreeableness is defined as altruism, affection, and prosocial behavior and its opposite pole is hostility (John et al., 2008). Lastly, openness to experience is defined as open-mindedness, originality, and generally describes the breadth, depth, and complexity of a person's inner life (John et al., 2008). Its opposite pole is closed-mindedness (Suchy, 2011). These traits were coined the Big Five in order to reflect their broadness (John et al., 2008). They are sufficiently broad to have predictive power while still discriminating between individuals. In fact, the Big Five personality traits have been linked to numerous important life outcomes.

Why the Big Five are important.

The Big Five personality traits have consistently demonstrated predictive validity. They are able to reliably predict a wide variety of important life outcomes, which can provide insight into vulnerability factors and, therefore, potential interventions. Neuroticism is associated with numerous negative life outcomes such as risk for early mortality, relationship dissatisfaction (Roberts et al., 2007), and criminality when

combined with low conscientiousness (Ozer & Benet-Martinez, 2006). Neuroticism by itself is negatively correlated with subjective well-being, happiness, and identity formation (Ozer & Benet-Martinez, 2006), and it is the trait that has been continuously associated with a variety of physical and mental health disorders. One longitudinal study examined the impact of neuroticism measured in a large group of Finnish men at age 20 on the emergence of mental disorders in this same group of men at age 35 (Lonnqvist, Verkasalo, Makinen & Henriksson, 2009). This study found that neuroticism at age 20 significantly predicted mental disorders and low self-esteem at age 35 even when psychosocial functioning and intelligence, as measured at age 20, were controlled.

Conscientiousness has been shown to predict a number of favorable life outcomes. One of these outcomes is longevity. Conscientiousness has consistently been linked to a longer lifespan in children, adult and elderly samples (Ozer & Benet-Martinez, 2006; Roberts et al., 2007). This effect holds even after gender, socioeconomic status (SES), and health difficulties are controlled (Roberts et al., 2007). Conscientiousness is also associated with longer marriages, stronger goal setting and self-efficacy (Roberts et al., 2007), as well as identity formation and job performance (Ozer & Benet-Martinez, 2006). Low conscientiousness is associated with higher rates of substance abuse, criminality, and poor quality of interpersonal relationships (Ozer & Benet-Martinez, 2006).

Extraversion is associated with longevity, leadership roles in occupational settings (Roberts et al., 2007), subjective well-being, popularity, status, and job satisfaction (Ozer & Benet-Martinez, 2006). Agreeableness is associated with longer marriages, careers focused on social interests, and empathy (Ozer & Benet-Martinez, 2006). Additionally,

low agreeableness predicts poor relationship satisfaction, criminality, and poor physical health (Ozer & Benet-Martinez, 2006). Openness to experience is the factor that has had the least amount of empirical support both in terms of its universality and in terms of its predictive power. Nevertheless, openness is associated with a higher incidence of substance abuse when combined with low conscientiousness (Ozer & Benet-Martinez, 2006). It has also been associated with investigative and artistic occupations (Ozer & Benet-Martinez, 2006). Although the broadness of these traits allows for predictions and generalizations to be made, subsumed under each of the traits are several personality characteristics called facets. Facets are narrower personality characteristics that add descriptive power to the broad five factors.

Big 5 facets.

Examining personality at the facet-level allows for more fine-tuned description of an individual's personality. Much valuable information is lost when simply examining personality at the trait level. The two most popular personality inventories that measure personality at the facet level are the Revised NEO Personality Inventory (NEO PI-R; Costa & McCrae, 1992), and the Big Five Inventory (BFI; John, Nauman & Soto, 2008). The NEO PI-R includes six facets for each trait while the BFI, which is a briefer measure of the Big Five traits, includes two facets for each trait. Facets are designed to sample the domain from which they are drawn, but they are not exhaustive, and they may load on more than one domain as domains themselves are not exclusive (Costa & McCrae, 1995).

On the NEO PI-R, neuroticism includes the facets anxiety, angry hostility, depression, self-consciousness, impulsivity, and vulnerability. Extraversion includes warmth, gregariousness, assertiveness, activity, excitement seeking, and positive

emotion. Openness to experience includes fantasy, aesthetics, feelings, ideas, actions and values. Agreeableness includes trust, straightforwardness, altruism, compliance, modesty, and tender-mindedness. Lastly, conscientiousness includes competence, order, dutifulness, achievement striving, self-discipline, and deliberation.

Research on the Big Five personality traits has begun to extend beyond self or other-report measures and behavioral observations. An increasing number of studies utilize various technologies that allow the researcher to examine differences in brain structures that are associated with differences in personality traits. Of particular interest for this study, several personality traits are associated with structural and functional variation in the OFC.

Personality Traits and the Orbitofrontal Cortex Region

Several personality traits have been correlated with variation in the structure and/or function of the orbitofrontal cortex (OFC) in studies utilizing fMRI or structural MRI techniques. Individuals who score low on neuroticism exhibit increased activation in the OFC in response to humor (Mobbs et al., 2005). Extraversion is associated with increased OFC volume (De Young et al., 2010), and OFC activation increases in response to humor (Mobbs et al., 2005) and in response to receiving a reward (Cohen et al., 2005). Agreeableness is also associated with the OFC. People who score low on agreeableness exhibit reduced grey matter volume in the OFC (Mahoney et al., 2011). Additionally, studies utilizing patients with lesions to the OFC found that OFC lesions were associated with impulsive aggression (Blair & Cipolotti, 2000**)**. Similarly, other studies found that anger induction was associated with OFC activation in healthy adults (Dougherty et al., 1999; Kimbrell et al., 1999). However, one study did not find any differences in

extraversion, neuroticism, agreeableness, or conscientiousness between patients with OFC lesions, patients without OFC lesions, and normal controls (Berlin, Rolls, & Kischka, 2004). Overall, therefore, it appears that "positive" personality traits, such as emotional stability and extraversion, may be associated with increased volume and increased activity in the OFC in response to rewarding stimuli, whereas "negative" personality traits, such as neuroticism and hostility, may be correlated with decreased volume in the OFC.

Additionally, research examining the relationship between olfaction and personality found that the anxiety and self-consciousness facets of neuroticism were significantly positively associated with olfactory threshold (Havlíček et al., 2012). There are also significant positive relationships of olfactory sensitivity with neuroticism (Pause et al., 1998) and extraversion (Koelega, 1970). Another study found a significantly positive relationship between olfactory sensitivity and agreeableness, but did not find any significant associations between neuroticism or extraversion and olfactory sensitivity (Croy et al., 2011). However, at least one study has failed to find a relationship between olfactory threshold, olfactory identification, and personality (Koelega, 1994). Another study measured olfactory sensitivity by measuring a participant's ability to correctly identify a shirt belonging to their roommate by smell alone (Zhou & Chen, 2009). They found a relationship between emotional awareness and olfactory sensitivity as well as between emotion recognition and olfactory sensitivity (Zhou & Chen, 2009). Although this study did not directly measure personality traits, these results support a potential relationship between olfaction and emotional awareness. It therefore appears that although research has documented a fairly reliable relationship between variability in the

structure and/or function of the OFC and personality, the relationship between personality traits and olfaction remains ambiguous. A clear pattern has emerged, however, linking OFC functioning to psychological disorders.

OFC dysfunction has been associated with a variety of anxiety problems including panic disorder (e.g., Asami et al., 2009; Sobanski et al., 2010), obsessive-compulsive disorder (Szesko et al., 1999), and trait anxiety (Kühn, Schubert, & Gallinat, 2011). Trait anxiety can be conceptualized as an aspect of personality that is stable and enduring and reflects an individual's propensity to experience and express anxiety-related feelings and behaviors (Kühn et al., 2011). Therefore, trait anxiety is a characteristic tendency to respond fearfully to a wide variety of stimuli (Kühn et al., 2011), which is one of the defining features of neuroticism. The extent to which trait anxiety is associated with both OFC function and neuroticism suggests the OFC plays a role in the expression of neuroticism.

The mOFC and the nucleus accumbens (NAcc) combine to influence fear acquisition (Kühn et al., 2011). Kühn et al. (2011) explored the relationship between structural variations in the mOFC and NAcc using participants with no history of medical, neurological, or psychiatric disorders, or with a first-degree family history of psychological disorders. Using imaging techniques, it was found that reduced cortical thickness in the right mOFC correlated significantly with increased trait anxiety. Trait anxiety also correlated with bilateral NAcc volume. This association was especially strong in the left NAcc. Further, the area within the mOFC that was negatively correlated with trait anxiety had been associated with anxiety disorders such as panic disorder, OCD, and PTSD in previous studies (e.g., Asami et al., 2009). The authors noted the

particular relevance of these findings given that their participants did not have a personal or first-generation family history of psychiatric disorders. Therefore, the cortical thinning found in the mOFC along with enlargement of the NAcc appear to reflect structural preconditions to the development of an anxiety disorder rather than consequences or side effects of an anxiety disorder. Additionally, this neurological vulnerability reflects both aspects of fear conditioning: enlarged NAcc increases sensitivity to form fear associations, while the reduced volume in the mOFC leads to difficulty extinguishing the fear response. This study by Kühn et al. (2011) demonstrates the importance of studying the neurological foundations of personality traits as potential risk factors for later development of mental health disorders.

Personality, PTSD, and Orbitofrontal Cortex

Personality traits, neurological processes, and PTSD symptomology appear to interact with one another in a complex manner that research has not been able to fully identify. From the research that has been conducted on each of these separate areas, a pattern does emerge such that individuals with PTSD may generally score relatively high on neuroticism and low on extraversion. They further suggest that neurological processes, especially those located within the OFC, underlie neuroticism and are associated with development of anxiety conditions such as PTSD. Research corroborates this link between neuroticism, extraversion, and PTSD, specifically in regard to symptom presentation.

Several studies have found that personality traits moderate symptom severity in PTSD. One study found a relationship between agreeableness and the avoidant symptom cluster of PTSD, whereby higher levels of agreeableness were associated with more

avoidant symptoms (Hyer et al., 1994). Another study found that neuroticism was more strongly related to the hyperarousal and avoidant symptom clusters than to the re-experiencing cluster, while introversion was correlated with avoidant symptoms (Rademaker, van Zuiden, Vermetten & Geuze, 2010). Thus, personality traits may work together to partially determine which symptoms will be most prevalent in a particular person's presentation of the disorder. For example, premorbid neuroticism may serve as a vulnerability factor in the development of PTSD. The other traits, rather than predicting PTSD development per se, may instead contribute to different symptom presentations and the general heterogeneity often observed in this population.

Research examining the relationship of neuroticism and extraversion to PTSD has largely focused on the prefrontal cortex; variation in the prefrontal cortex size and activation is associated with expressions of neuroticism, extraversion, and PTSD. As previously explained, dysfunction in the prefrontal cortex is implicated in the maintenance of PTSD (Cardenas et al., 2011). Individuals with PTSD exhibit overall thinning in the prefrontal cortex compared to control participants without PTSD (Geuze et al., 2008; Milad et al., 2005; Rauch et al., 2003; Rauch et al., 2005). This generally reduced volume in the prefrontal cortex is thought to play a role in the inadequate control exercised by the prefrontal cortex over the amygdala in response to amygdala activation (Brewin, 2001a; 2001b; Cardenas et al. 2011). Similarly, several Big Five traits are associated with gross structural and functional variation in the prefrontal cortex. Individuals who score high on neuroticism exhibit reduced volume in the dorsomedial prefrontal cortex (De Young et al., 2010) and less activation in the right prefrontal cortex in response to humor (Mobbs et al., 2005). Extraversion, on the other hand, is associated

with increased activation in the right prefrontal cortex in response to humor (Mobbs et al., 2005).

Research specifically examining the orbitofrontal cortex also leads to the conclusion that PTSD may be associated with high neuroticism and low extraversion. Individuals with PTSD exhibit reduced volume in the OFC (Dileo et al., 2008; Eckart et al., 2011). Individuals who score low on neuroticism exhibit increased activation in the OFC in response to humor (Mobbs et al., 2005). Similarly, extraversion is associated with increased volume in the OFC (De Young et al., 2010) as well as increased activation in response to humor (Mobbs et al., 2005) and in response to receiving a reward (Cohen et al., 2005). Additionally, one study found that extinction retention -- the ability to recall that a conditioned stimulus no longer predicts danger -- and increased volume in the mOFC are positively associated with extraversion (Rauch et al., 2005)**.** Further, using path analysis, this same study found that extinction retention mediated the relationship between volume in the mOFC and extraversion (Rauch et al., 2005). Therefore, increased volume or activity in the OFC is associated with emotional stability and extraversion, whereas reduced volume is associated with neuroticism and PTSD. At this point, it is impossible to definitively conclude whether these personality traits precede the development of the disorder, arise after the experience of the trauma, or whether these personality traits moderate the severity of symptoms present in PTSD.

At least two studies have linked premorbid levels of neuroticism or trait anxiety to development of PTSD following exposure to a traumatic stressor (Kühn, Schubert, Gallinat, 2011; Parslow, Jorm & Christensen, 2006). Another study documented accelerated atrophy in several brain areas that are associated with neuroticism following

the onset of PTSD (Cardenas et al., 2011). This seems to suggest that neuroticism and its associated neurological underpinnings may predispose an individual to the development of PTSD, and in turn, PTSD may, at least partially, change a person's personality to reflect higher levels of neuroticism and lower levels of extraversion. There may, therefore, be a complex interaction between one's premorbid personality traits and the neurological changes that result from PTSD. This interaction may serve to maintain the disorder or it may moderate symptom severity.

Current Study

The purpose of the current study was to explore the relationship between personality traits, OFC dysfunction, and PTSD. The hypotheses were as follows:

Hypothesis 1: Personality traits would be related to olfactory sensitivity such that

a) as neuroticism scores increase, olfactory sensitivity would decrease, and
b) as extraversion scores increase, olfactory sensitivity would increase.

Hypothesis 2: PTSD would be related to olfactory sensitivity such that as PTSD symptoms increase, olfactory sensitivity would decrease.

Hypothesis 3: Neuroticism and extraversion would moderate the relationship between PTSD and olfactory sensitivity such that individuals with high PTSD symptoms and high neuroticism would exhibit decreased olfactory sensitivity when compared with individuals with high PTSD symptoms and low neuroticism scores. No moderation is expected between low PTSD symptoms and neuroticism scores. Similarly individuals with high PTSD symptoms and high extraversion scores would exhibit greater olfactory sensitivity than individuals with high PTSD symptoms and low extraversion scores. No

moderation is expected between low PTSD symptoms and extraversion scores. Additionally, a three-way interaction between extraversion, neuroticism, and PTSD symptoms was examined.

Exploratory analyses examining potential relationships between Big Five personality traits, personality facets, and PTSD symptom clusters were also conducted. These analyses represent a novel contribution to the field, as research has not yet examined how personality traits and facets impact the expression of particular PTSD symptom clusters.

Chapter II: Method

Participants

Participants included 107 undergraduate college students, 44 males and 63 females, were recruited from undergraduate psychology courses in exchange for research credit. Mean age for participants was 25.45 years (*SD* = 7.07, range = 18-52; see Table 1 for all descriptive data). Twenty-two participants indicated that they have served in the military. Of the 22 participants who served in the military, 18 of them were deployed. The mean total PTSD score was 35.45 (*SD* = 13.12, range = 17-80, median = 34.00). Participants who reported having served in the military reported significantly higher levels of total PTSD symptoms (*M* = 41.82, *SD* = 16.24) than participants who reported no military service (*M* = 33.81, *SD* = 11.75), $F(1, 107) = 6.86$, $p = .01$. However, participants who served in the military did not significantly differ from participants who did not serve in the military on measures of olfactory sensitivity, neuroticism, or extraversion. Fifty-eight participants endorsed a clinically significant number of total PTSD symptoms, defined as a total score of 30 or above in the civilian population (VA National Center for PTSD, 2012). Of these 58 participants who reported clinically significant PTSD symptoms, 57 of them reported a history of trauma exposure. Participants were recruited by classroom announcements, fliers posted around the campus, and an online posting on a website used by the university to recruit students for participation in psychology research studies. Participants received research credit in exchange for their participation.

It is interesting to note that 54% of the participants in this sample reported PTSD symptoms falling above the clinical cutoff. This percentage is very high compared to the

rate of PTSD symptoms typically found in the college student population, which is estimated at 8-9% (Frazier et al., 2009; Read et al., 2011). The reason for the higher distress observed in this sample is unclear. However, the age range of the participants, with 21.7% of the participants falling over the age of 30, may at least partially explain this higher level of distress, since the older a participant is, the more likely they are to have experienced a traumatic event ($\beta = .72$, $p < .001$). Another potential explanation is that the title of the study used to recruit participants was "PTSD, personality, and brain functioning." It is therefore possible that this title attracted a higher number of individuals struggling with PTSD symptoms.

Upon entering the research laboratory, the participant was greeted by a trained research assistant who asked the participant a series of questions to determine participation eligibility. Exclusion criteria included a documented physiological brain impairment or epilepsy, history of head injury that resulted in loss of consciousness for more than 30 minutes, a current medical condition that impairs respiratory processes and a history of nasal trauma. Participants who indicated that they had experienced any of the above-listed exclusionary criteria did not proceed with the study but were awarded one research credit for their attendance. No participants were excluded from participation based on these criteria. Other factors including head injury resulting in loss of consciousness for less than 30 minutes, medical conditions not impacting respiratory processes, substance abuse disorders, mental health disorders (e.g., mood, anxiety, bipolar, and schizophrenia disorders) and psychotropic medication use were assessed as potential covariates but were not used to exclude individuals from participation.

Measures

Olfactory identification.

Olfactory identification was assessed using "Sniffin' Sticks" (Burghart Medzintechnik, Wedel, Germany). In this test, participants were presented with one felt-tipped pen at a time for a total of 16 pens. They were asked to identify the odor of the pen out of four choices. The pens contain both positive (e.g., banana) and negative (e.g., turpentine) odors. Hummel et al., (1997) found that odor identification on the "Sniffin' Sticks" has a test-retest reliability of 0.73. Although produced in Germany, "Sniffin' Sticks" has been internationally utilized as a tool for assessing olfactory identification and olfactory threshold. Researchers in the United States have used "Sniffin' Sticks" to study schizophrenia (e.g., Kamath et al., 2014) and Alzheimer's Disease (Seligman, Kamath, Giovannetti, Arnold, & Moberg, 2013), among other conditions. The "Sniffin' Sticks" test was chosen over another commonly used odor identification test known as the University of Pennsylvania Smell Identification Test (UPSIT) due to its greater affordability. There does not appear to be any research correlating the "Sniffin' Sticks" olfactory identification test to the UPSIT olfactory identification test. However, the relative affordability of the "Sniffin' Sticks" as compared to the UPSIT means that this test is more likely to be utilized within clinical settings. Therefore, more research utilizing the "Sniffin' Sticks" test is needed.

Life Stressor Checklist – Revised (LSC-R).

The Life Stressor Checklist – Revised (LSC-R; Wolfe &Kimberling, 1997) is a self-report inventory that assesses 30 stressful life events that are not exclusive to combat related trauma. This measure assesses for the presence of stressful life events that would

meet DSM-IV critierion A for PTSD (e.g., exposure to actual or threatened serious injury or death, to which an individual reacted with intense fear, helplessness, or horror). It also includes events that are considered stressful, but not "traumatic." This measure includes a number of stressful events, including experiences with natural disasters, physical or sexual assault, death of a relative, and other events. An example of an item is "Has someone close to you died suddenly or unexpectedly (for example, from a sudden heart attack, murder, or suicide)?" Participants respond to each item in a yes/no format. For events endorsed with a yes response, participants were asked a series of follow-up questions, including age when the event began, age when the event ended, belief that they were at risk of harm (yes/no), and feelings of helplessness (yes/no). Additionally, participants were asked about the extent to which the event affected their lives and how upsetting the event was at the time on a 5-point scale from 1 (not at all) to 5 (extremely). Participants were then asked to identify the three events that currently have the greatest impact on them. This measure has demonstrated good test-retest reliability, with an across item average of .70 (McHugo et al., 2005).

Combat Exposure Scale (CES).

The Combat Exposure Scale (CES; Keane et al., 1989) is a 7-item self-report measure that assesses exposure to wartime stressors. An example of an item is, "Were you ever surrounded by the enemy?" Participants either respond on a 5-point frequency scale from 1(no, or never) to 5 (more than 50 times), a 5-point duration scale from 1 (never) to 6 (more than 6 months), a 4-point frequency scale from 1 (no, or never) to 4 (more than 12 times), or a 4-point degree of loss scale from 1 (no one) to 4 (more than

50%). The total CES score is calculated by summing weighted item scores. The total score can range from 0 to 41, and can be classified into one of five categories of combat exposure ranging from "light" to "heavy." This measure has demonstrated high levels of test-retest reliability (r = .97) and high internal consistency (α = *.85*; Keane et al., 1989). Internal consistency in this study was found to be excellent (α = .99).

PTSD Checklist – Civilian Version (PCL-C).

The PTSD Checklist-Civilian Version (PCL-C; Weathers, 1993) is a 17-item self-report measure that assesses the DSM-IV criteria for PTSD. This measure asks about PTSD symptoms that have occurred in response to stressful experiences. An example of an item is "Repeated disturbing memories, thoughts, or images of a stressful experience." Participants respond on a scale from 1 (not at all) to 5 (extremely), indicating the degree to which the described symptom has bothered him or her over the last month. A total symptom severity score ranging from 17 to 85 is calculated by summing the scores from each item. The PCL-C has demonstrated high levels of internal consistency (α = .94) and moderate test-retest reliability (r = .66; Conybeare, Behar, Solomon, Newman, Borkovec, 2012). The PCL-C also correlates stronger with other measures assessing PTSD symptomology than with measures assessing mood disorders (e.g., anxiety and depression), thereby demonstrating convergent and discriminant validity (Conybeare et al., 2012). In this study, internal consistency on the PCL-C was found to be excellent (α = .91).

International Personality Item Pool (IPIP-NEO) version of the NEO PI-R.

The International Personality Item Pool (IPIP-NEO; Goldberg, 1999) is a 300-item self-report measure designed to assess the Big Five personality traits and 30

personality facets. The IPIP-NEO is the public version of the widely used NEO PI-R (Costa & McCrae, 1992). Participants are asked to respond on a scale from 1 (very inaccurate) to 5 (very accurate) regarding the extent to which the phrase describing people's behavior accurately describes how they generally are now. An example of an item is "worry about things." This measure is scored by calculating the mean score of all items contained within each scale. The IPIP-NEO has demonstrated high reliability ranging from $\alpha = .91$ to $\alpha = .94$, with a median of $\alpha = .93$ (Maples, Guan, Carter, & Miller, 2014). Similarly, reliability of the facet scales range from $\alpha = .58$ to $\alpha = .88$ with a median of $\alpha = .83$ (Maples, Guan, Carter & Miller, 2014). The IPIP-NEO has also demonstrated high convergent validity with the NEO PI-R, ranging from $r = .88$ to $r = .91$, with a median of $r = .89$ at the trait level (Maples, Guan, Carter, & Miller, 2014). Facet-level convergent validity with the NEO PI-R ranged from $r = .55$ to $r = .85$ with a median of $r = .76$ (Maples, Guan, Carter, & Miller, 2014). In this study, internal consistency on the IPIP-NEO was found to range from good to excellent at the trait level ($\alpha = .84$ to $\alpha = .94$). At the facet level, internal consistency was found to range from ($\alpha = .62$ to $\alpha = .91$).

Hospital Anxiety and Depression Scale (HADS).

The Hospital Anxiety and Depression Scale (HADS; Zigmond & Snaith, 1983), is a brief 14-item self-report measure that assesses symptoms of depression and anxiety. An example of an item is "I have lost interest in things." Participants respond on a scale from 0 (not at all) to 3 (yes definitely). The HADS yields a depression scale and an anxiety scale. Items for each scale are summed, and cutoff scores are provided to determine whether the individual is likely experiencing symptoms of anxiety or depression. The

HADS has been extensively utilized internationally as a screening tool for symptoms of anxiety and depression (Herrmann, 1997). Internal consistency has been widely reported to fall above $\alpha = 0.8$ across a variety of populations (Johnston, Pollard, & Hennessey, 2000). Other psychometric investigations of this measure have demonstrated high test-retest reliability, sensitivity to change in symptoms, and validity (Herrmann, 19997). In this study, internal consistency on the HADS was found to be good ($\alpha = .86$).

North American Adult Reading Test (NAART).

The North American Adult Reading Test (NAART) is a brief measure designed to estimate premorbid intellectual functioning (Nelson & O'Connell, 1978). It consists of 50 words with atypical pronunciations and is designed to assess familiarity with words rather than the individual's ability to phonetically decode words. The participant read listed words aloud and the researcher records whether the words were pronounced correctly or incorrectly. The NAART correlates with the Wechsler Adult Intelligence Scale (WAIS) Full Scale intelligence scores (Crawford et al., 1989). Crawford et al., found that NAART total scores shared 66% of the variance with WAIS Full Scale IQ scores.

Altman Self-Rating Mania Scale (ASRMS).

The Altman Self-Rating Mania Scale (ASRM) is a brief 5-item self-report mania scale designed to assess the presence and/or severity of manic symptoms according to DSM-IV diagnostic criteria (Altman, Hedeker, Peterson, Davis, 1997). For each DSM-IV mania criterion, the ASRM has a group of 5 statements that represent a continuum of the symptom. The participant endorses which statement best reflects what they have experienced over the past week. An example of an item is, "0 = I do not feel happier or more cheerful than usual, 1 = I occasionally feel happier or more cheerful than usual, 2 =

I often feel happier or more cheerful than usual, 3 = I feel happier or more cheerful than usual most of the time, 4 = I feel happier or more cheerful than usual all of the time." All five items are summed to yield a total score for the presence of manic symptoms. The ASRM has been found to have a high internal consistency of α = .79 (Rucci, Calugi, Miniati, & Fagiolini, 2013). It is also highly correlated with two widely used clinician-administered measures for the assessment of mania. Specifically, it is highly correlated with the Clinician-Administered Rating Scale for Mania (CARS-M; r = .77) and the Mania Rating Scale (MRS; r = .72). In this study, internal consistency on the ASRM was found to be acceptable (α = .69).

Demographic questionnaire.

A demographic questionnaire was constructed that included items regarding the participant's sex, age, history of head injury, the presence of current and historical medical conditions, historical diagnoses of bipolar disorder or schizophrenia, substance use, and current prescription medications. Participants were also asked whether they had experienced nasal congestion or other type of respiratory problem in the last month.

Procedure

All procedures were approved by the Idaho State University Human Subjects Committee. Participants were recruited from psychology courses via class announcements and a link on SONA. When participants arrived at the designated location, the researcher administered a brief screening questionnaire (Appendix A) to ensure the participant did not endorse any exclusion criteria. The participant then read the informed consent on the computer and any questions were answered. After the participant read the informed consent and agreed to participate, he/she completed the NAART. Next,

participants completed the following series of questionnaires on a computer: the Life Stressor Checklist-Revised (LSC-R), the Combat Exposure Scale (CES; if combat exposure is endorsed), PTSD Checklist – Civilian (PCL-C), the International Personality Item Pool version of the NEO-PI-R, the Disinhibition Inventory (DIS-I), the BIS/BAS scales, the Hospital Anxiety and Depression Scale (HADS), and the Altman Self-Rating Mania Scale. When these measures were complete, the participant was administered the "Sniffin' Sticks" test. Lastly, the participants completed the demographic questionnaire on the computer. [1]

[1] Two other measures were also administered but were not included in analyses for this study. They are the Disinhibition Inventory (DIS-I; Dindo, McDade-Montez, Sharma, Watson, & Clark, 2009) and the BIS/BAS Scales (Carver & White, 1994).

Chapter III: Results

Given the large number of analyses that were conducted, some consideration must be given to Type I error, or the likelihood that the significant results obtained in this study are due to chance. With a p value of .05, we would expect that 5% of the analyses would result in an incorrect rejection of the null hypothesis. Twenty analyses were conducted exploring the relationship between PTSD symptoms and personality traits (4 PTSD symptoms x 5 personality traits). Of these analyses, 1 result out of 20 would be expected to be significant due to Type I error. Results of these analyses yielded 4 significant findings, which is four times greater than what would be expected based on chance alone. Therefore, this provides some confidence that the results of these analyses are due to the correct rejection of the null hypothesis. Additionally, 120 analyses (4 PTSD symptoms x 30 personality facets) were conducted exploring the relationship between PTSD symptoms and personality trait facets. Of these analyses, 6 results out of 120 would be expected to be significant due to Type I error. Results of these analyses yielded a total of 21 significant findings. Since the number of significant results is nearly four times greater than what would be expected based on chance alone, this again provides confidence that these results are due to the correct rejection of the null hypothesis. Regarding analyses involving olfactory identification, 21 analyses (5 traits + 5 facet + 5 PTSD symptoms + 6 interactions) were performed exploring the relationship between personality traits/facets and olfactory identification. Of these, 1.05 results would be expected to be significant due to Type I error. Results revealed eight significant findings, again providing support that these results are not due to chance. Overall,

therefore, despite the large number of analyses that were conducted, it appears that the number of significant findings far exceed what would be expected based on Type I error.

Covariates

Prior to initiating analyses, all predictor variables were standardized with a mean of zero and a standard deviation of one, in order to improve interpretability of the results. A correlation matrix was created that included all variables of interest to assist in identifying potential covariates. Age (r = .20, p = .04) and mania (r = -.20, p = .04) were the only variables that were significantly correlated with OI (see Table 2 for full correlation matrix). Bivariate regression analyses were performed on several variables (IQ, gender, age, depression, anxiety, mania, and head injury) that had been identified as potential covariates. Since the NAART was used to assess IQ and this method involves the ability to read a list of English words with atypical pronunciations, the data of the non-native English speakers (n = 4) were excluded from analyses used to determine whether the NAART IQ score significantly predicted olfactory sensitivity (OI). A bivariate regression analysis demonstrated that NAART IQ did not significantly predict OI (β = .005, p = .96). Since NAART IQ was not a significant predictor of OI, data from the four previously excluded participants were used in all further analyses.

A series of bivariate regression analyses were conducted to determine whether the potential covariates significantly predicted OI. The following variables did not significantly predict OI: gender (β = .06, p = .51), depression (β = -.10, p = .29), and anxiety (β = -.04, p = .68). The presence of a head injury was measured in several ways. Participants were asked the number of times they had experienced a head injury, they

were asked to indicate whether they had ever experienced a head injury resulting from any of various listed possible ways, and they responded to a series of questions to determine the presence of a Traumatic Brain Injury (TBI). The number of times a participant had experienced a head injury did not significantly predict OI (β = .02, p .80). Similarly, the sum of different types of head injuries endorsed did not significantly predict OI (β = .01, p = .91). Lastly, the sum of TBI symptoms endorsed did not significantly predict OI (β = -.14, p = .16). Results revealed that age (β = .20, p = .04) and mania (β = -.20, p = .04) were significant predictors. Therefore, age and mania were identified as two significant covariates and were included in all further analyses. Age and mania were significantly negatively correlated (r = -.23, p = .02).

Hypothesis 1

Hypothesis 1a was that neuroticism and olfactory sensitivity would be significantly inversely related such that as neuroticism increased, olfactory sensitivity would decrease. This hypothesis was tested with a hierarchical regression. The two significant covariates, age and mania, were entered in the first step and neuroticism was entered in the second step (see Table 3). Neuroticism did not significantly predict OI (β = .04, p = .72). Hypothesis 1b was that extraversion and OI would be significantly positively related such that as extraversion scores increased, olfactory sensitivity would also increase. Hypothesis 1b was tested with a hierarchical regression with the two covariates entered in the first step. Extraversion also did not significantly predict OI (β = .13, p = .23). Therefore, Hypothesis 1 was not supported: neither neuroticism nor extraversion significantly predicted olfactory sensitivity (see Table 3).

Hypothesis 2

Hypothesis 2 was that PTSD symptoms would be inversely related to OI such that as PTSD symptoms increased, olfactory sensitivity would decrease. PCL-C total scores were used as a continuous measure of PTSD symptoms. This hypothesis was tested with a hierarchical regression in which the two covariates, age and manic symptoms, were entered in the first step and total PTSD symptoms were entered in the second step. PTSD symptoms did not significantly predict OI (β = -.11, p = .26). Therefore, Hypothesis 2 was not supported (see Table 4).

In addition to exploring the relationship between total PTSD symptoms and olfactory sensitivity, the relationship between PTSD symptom clusters and olfactory sensitivity was also investigated. A hierarchical regression analysis was performed with mania and age entered in the first step and all PTSD symptom clusters entered in the second step. The re-experiencing symptom cluster of PTSD approached significance (β = -.26, p = .06; see Table 4). A hierarchical regression analysis exploring the relationship between the re-experiencing symptom cluster and olfactory sensitivity, covarying for age and manic symptoms, revealed that in the regression model containing only the one symptom cluster (re-experiencing symptoms) and the two covariates, the re-experiencing symptom cluster was a significant predictor of OI (β = -.20, p = .04; see Table 4). Therefore, as re-experiencing symptoms increased, olfactory sensitivity decreased. All other analyses that included total PTSD symptoms as a dependent variable were also conducted with the re-experiencing symptom cluster.

Hypothesis 3

Hypothesis 3 was that the personality traits of neuroticism and extraversion would interact with PTSD symptoms to predict olfactory sensitivity. This hypothesis was tested using a set of hierarchical regressions with age and mania entered in the first step, and the trait (neuroticism or extraversion), PTSD symptoms, and the interaction term entered in the second step. The interaction between neuroticism and PTSD was not significant (β = -.11, p = .28; see Table 5). The regression model testing the interaction between extraversion and PTSD was also not significant (β = -.09, p = .38; see Table 5). The regression model testing a three-way interaction between neuroticism, extraversion, and total PTSD scores (with the covariates entered in the first step; and neuroticism, extraversion, PTSD symptoms, and the three-way interaction entered in the second step) demonstrated that the three-way interaction was not significant (β = -.03, p = .85; see Table 6). Therefore, Hypothesis 3 was not supported. Total PTSD symptoms did not interact with neuroticism or extraversion to predict olfactory sensitivity, and there was not a three-way interaction[2].

Hypothesis 3 was also tested using the re-experiencing symptom cluster of PTSD with the same series of hierarchical regression analyses. This hypothesis was tested with a set of hierarchical regressions with age and mania entered in the first step, and the trait (neuroticism or extraversion), re-experiencing symptoms, and the interaction term entered in the second step. The interaction between neuroticism and re-experiencing

[2] All main hypothesis analyses were also conducted with participants over the age of 35 removed, since older age is correlated with decreased olfactory sensitivity. Removing these participants did not change the results of any of the three main hypotheses.

symptoms was not significant (β = -.10, p = .34; see Table 7). The regression model testing the interaction between extraversion and re-experiencing symptoms was also not significant (β = -.09, p = .37; see Table 7).

The regression model testing a three-way interaction between neuroticism, extraversion, and re-experiencing symptoms with the covariates entered in the first step; and neuroticism, extraversion, re-experiencing symptoms, and the three-way interaction entered in the second step) demonstrated that the three-way interaction between neuroticism, extraversion, and re-experiencing symptoms was not significant (β = -.06, p = .63; see Table 8).

Exploratory Analyses

Exploratory analyses were conducted exploring the relationship between other Big Five personality traits, re-experiencing symptoms, and OI. A hierarchical regression analysis was performed whereby the two covariates were entered in the first step and all Big Five traits, as well as re-experiencing symptoms, were entered in the second step. This model was found to significantly predict olfactory sensitivity (F(8, 97) = 3.02, p = .004). Within this model, neuroticism (β = .52, p = .001), conscientiousness (β = .27, p = .03), and extraversion (β = .29, p = .03) had significant positive relationships with olfactory sensitivity; and re-experiencing symptoms significantly negatively predicted OI (β = -.37, p = .002; see Table 9).

Exploratory analyses were performed to explore potential relationships between Big Five personality facets and olfactory sensitivity. These relationships were tested using hierarchical regression analyses containing age and manic symptoms in the first

step and the six facets of the trait being tested in the second step. The anxiety facet of neuroticism was found to have a significant positive relationship with OI (β = .44, p = .003; see Table 10). No other facet models significantly predicted OI (see Tables 11, 12, 13, and 14).

Exploratory analyses were also conducted exploring the relationship between Big Five personality traits, facets, and the re-experiencing symptom cluster of PTSD since this was the symptom cluster found to significantly predict OI. A multiple regression analysis containing previously identified potential covariates was performed. Only anxiety as measured by the HADS (β = -.48, p < .001) and age (β = .18, p = .04) emerged as significant predictors. Therefore, all further analyses exploring the relationship of the Big Five personality facets with re-experiencing symptoms included anxiety and age as covariates. Additionally, the anxiety facet of neuroticism was not included in analyses using the neuroticism facets since it is a similar construct to the HADS anxiety score that is used as a covariate in these analyses.

Hierarchical regression analyses were performed to explore the relationship between the Big Five personality traits and the re-experiencing symptom cluster of PTSD where the two significant covariates were entered in the first step and the five personality traits were entered in the second step. Results revealed that neuroticism (β = .43, p = .01) and conscientiousness (β = .25, p = .02) significantly positively predicted re-experiencing symptoms such that as levels of neuroticism and conscientiousness increased, re-experiencing symptoms also increased (see Table 15). Results also demonstrated that agreeableness significantly negatively predicted re-experiencing symptoms, such that as

levels of agreeableness increased, re-experiencing symptoms decreased (β = -.19, p = .04).

Hierarchical regression analyses were performed to investigate the relationship of the Big Five personality facets with the re-experiencing symptom cluster of PTSD where the two significant covariates were entered in the first step and the personality facets were entered in the second step. The activity facet of extraversion significantly predicted re-experiencing symptoms (β = .29, p = .001), such that as reported activity level increased, re-experiencing symptoms also increased (see Table 11). For the conscientiousness facets, as levels of achievement striving increased, re-experiencing symptoms also increased (β = .25, p = .04); and as levels of dutifulness increased, re-experiencing symptoms decreased (β = -.26, p = .01; see Table 13). For the six openness facets, the liberal facet was the only one to approach significance (β = .16, p = .06), such that as levels of liberality increased, re-experiencing symptoms also increased (see Table 14). None of the neuroticism (see Table 10) or agreeableness facets (see Table 12) significantly predicted re-experiencing symptoms. Exploratory analyses were also conducted to explore the relationship between personality traits/facets, PTSD total scores, and PTSD symptom clusters. See Appendix B for a full discussion of these exploratory analyses.

Chapter IV: Discussion

Hypothesis 1

The first hypothesis was that personality traits would be related to olfactory sensitivity such that as OI increased, neuroticism scores would also increase and extraversion scores would decrease. Results did not support this hypothesis as neither neuroticism nor extraversion were significantly related to OI. Despite the null finding, this result is interesting in that it is inconsistent with prior research demonstrating a relationship between these two personality traits and OFC functioning (Cohen et al., 2005; De Young et al., 2010; Mobbs et al., 2005), as well as research demonstrating a relationship between olfactory sensitivity and neuroticism and extraversion (Croy et al., 2011; Havliček et al., 2012; Koelega, 1970; Pause et al., 1998). However, this finding is consistent with other research that failed to find a relationship between these personality traits and tests of olfactory sensitivity (Koelega, 1994). Of note, several of these studies (Koelega, 1970; Koelega, 1994; Pause et al., 1998) did not use a standardized OI test. Therefore, one possible explanation for the mixed findings related to the relationship between olfactory sensitivity and personality is the varied methods of assessing olfactory sensitivity. It is interesting to note, however, that one study did find a significant relationship between agreeableness and olfactory sensitivity using the "Sniffin' Sticks" and the NEO-FFI, an abbreviated version of the NEO PI-R (Croy et al., 2011). Therefore, another possible reason for the mixed findings may be the various methods used to assess personality traits. Studies have used the NEO-FFI, the Big Five Inventory, the NEO PI-R, as well as other, less commonly used measures that only assess neuroticism and extraversion, rather than all of the Big Five traits.

Another potential explanation is that the sensitivity of OI tasks to OFC functioning may be low, and that the observed variations in structure and/or activity in the OFC that have been found to be associated with neuroticism and extraversion are too subtle to be detected with an OI task. Additionally, OI tasks in general, or the "Sniffin' Sticks" in particular, may not precisely measure the area of the OFC most strongly associated with neuroticism and extraversion. For example, research has suggested that reduced cortical volume in the mOFC is significantly associated with increased levels of trait anxiety (Kühn et al., 2011). Research has additionally suggested that the mOFC, and the right mOFC in particular, is involved not only in olfactory sensitivity but also in judging the pleasantness or unpleasantness of the odor. The "Sniffin' Sticks", however, did not contain sufficient sticks to be able to measure differences in participants' abilities to identify pleasant vs. unpleasant odors. Similarly, variations in results have been observed between olfactory threshold detection tasks (absolute sensitivity) versus olfactory discrimination. Some research has suggested that the right nostril is superior in odor discrimination but not in absolute sensitivity (Martinez et al., 1993). Since the "Sniffin' Sticks" test used in this study is an identification task rather than either a threshold or a discrimination task, and since this test was not administered to individual nostrils, this cannot be assessed. Consistent with this, some research has found associations between neuroticism and extraversion in terms of absolute sensitivity using the "Sniffin' Sticks" threshold task but has failed to find a relationship between neuroticism and extraversion in terms of olfactory identification (Havlíček et al., 2012).

Hypothesis 2

The second hypothesis was that total PTSD symptoms would be inversely related to OI such that as PTSD symptoms increased, olfactory sensitivity would decrease. This hypothesis was not supported, as total PTSD symptoms did not significantly predict olfactory sensitivity. This result is inconsistent with prior research demonstrating a significant relationship between olfactory sensitivity and PTSD symptoms in Vietnam Veterans (Dileo et al., 2008; Vasterling et al., 2000). There are several potential explanations for this discrepancy. One possible explanation is that since the PTSD diagnosis was originally formulated based on symptoms observed in combat veterans, combat veterans are therefore more likely to experience a higher number of "classic" PTSD symptoms when their PTSD is due to trauma experienced during combat. However, in the college student population, it is possible that the symptom presentation of PTSD captured from individuals who may have more extensive trauma histories, including childhood trauma and sexual abuse, may be different from that of the combat veteran. This potential difference in type, number, and recency of traumatic exposures may lead to differences in neurological functioning. For example, a Veteran who was exposed to trauma only in the course of military service may look quite different from an individual who was exposed to chronic sexual abuse throughout childhood, both in terms of symptom presentation and neurological functioning. Additionally, many factors could impact olfactory functioning in Vietnam Veterans aside from neurological functioning and PTSD symptoms (e.g., age, smoking history). One of the goals of this study was to determine whether results from studies conducted on Vietnam Veterans could generalize

to a younger population. Results of this study therefore suggest that those results cannot yet be generalized to the college-aged population.

Another potential explanation for the non-significant finding between total PTSD symptoms and OI is that the test used in this study is a different test than what was used in the studies that found a significant difference between Vietnam Veterans with and without PTSD in terms of olfactory sensitivity (Dileo et al., 2008; Vasterling et al., 2000). These two studies utilized a 40-item smell test that allowed for the analysis of differences in identification of differently valenced odors (i.e., pleasant versus unpleasant) as well as for an overall score. Although these studies did find differences in the overall number of correctly identified odors regardless of the valence, it appears that the "Sniffin' Sticks", which only contains 16 odors, may have been limited in its ability to detect a difference by its brevity.

In addition to exploring the relationship between total PTSD symptoms and OI, the relationships between PTSD symptom clusters and OI were also explored. Results revealed a significant negative association between the re-experiencing symptom cluster of PTSD and olfactory sensitivity. Therefore, as the number of re-experiencing symptoms increased, performance on the OI task decreased. This is an interesting result, as re-experiencing symptoms are often triggered by olfactory stimuli. Therefore, one may logically surmise that as re-experiencing symptoms increased, olfactory sensitivity would also increase, since it may reflect a heightened level of awareness regarding olfactory stimuli. However, it appears that the opposite occurred, and perhaps individuals experiencing a greater number of re-experiencing symptoms may actually be less sensitive to olfactory stimuli.

Alternatively, it is also possible that individuals with more re-experiencing symptoms may be equally as sensitive to odorants as those with fewer re-experiencing symptoms, but may experience more difficulty identifying the odor. Odor identification deficits could be the result of retrieval difficulties, although the forced choice format of this OI task is designed to ameliorate that potential difficulty. Odor identification difficulties could also potentially be the result of a participant's distraction due to the frequency of re-experiencing symptoms and/or possibly a tendency to avoid olfactory stimulation for fear of being triggered.

However, the finding that re-experiencing symptoms are negatively associated with OI makes sense theoretically since re-experiencing symptoms are the particular symptoms that result from fear conditioning (i.e., trauma exposure). Since the OFC is involved in fear extinction recall, and it has been hypothesized that individuals with PTSD have a dysfunctional OFC that is manifest in fear extinction recall deficits, a higher level of re-experiencing symptoms would be expected to be associated with lower OI. This finding therefore provides partial support for Hypothesis 2.

Hypothesis 3

The third hypothesis was that personality traits would interact with PTSD symptoms to predict olfactory sensitivity. This hypothesis was not supported, as the interaction between neuroticism and total PTSD symptoms; the interaction between extraversion and PTSD; and the three-way interaction between neuroticism, extraversion, and PTSD symptoms, did not significantly predict OI. Given the absence of significant findings between the individual personality traits and OI as well as total PTSD symptoms

and OI, this finding is not surprising. These findings could be due to any number of explanations previously discussed, or a combination thereof.

Exploratory Analyses

Exploratory analyses were conducted to explore the relationship between other Big Five personality traits, personality facets, and olfactory sensitivity. Results revealed a significant positive relationship between the anxiety facet of neuroticism and olfactory sensitivity. This is consistent with research that found a relationship between the anxiety facet of neuroticism and olfactory threshold (Havliček et al., 2012). It is also consistent with Kühn et al.'s (2011) research that found a relationship between cortical thinning in the mOFC and trait anxiety, since the anxiety facet of neuroticism closely resembles the trait anxiety construct. This may suggest that a tendency to experience anxiety is a more biologically-based phenomenon than the behaviors and attitudes assessed by the other personality traits/facets. Therefore, the relationship between OFC functioning and anxiety may be more robust than what is found with the other traits/facets. It is also possible that anxiety and the variations observed in the OFC serve as a structural precondition to the development of anxiety disorders, as is suggested in other research (Kühn et al., 2011). It is also interesting to note that the direction of the relationship is opposite to the direction of the relationship originally hypothesized to exist between neuroticism and OI. This is consistent with previous research that has found a positive relationship between neuroticism and OI (Havliček et al., 2012; Pause et al., 1998). This relationship may be a result of the increased sensitivity to sensory stimuli that is hypothesized to exist in individuals higher in neuroticism, and possibly most especially in those with higher

levels of the anxiety facet of neuroticism, as smell can be a powerful indicator of potential threat (e.g., Egloff & Hock, 2001).

Re-experiencing Symptoms.

Exploratory analyses were also conducted exploring the relationship between personality traits/facets and PTSD symptom clusters. Results demonstrated that neuroticism and conscientiousness were positively associated with re-experiencing symptoms while agreeableness was negatively associated with re-experiencing symptoms. At the facet level, results revealed that the activity facet of extraversion, achievement-striving facet of conscientiousness, and the liberal facet of openness were all positively associated with re-experiencing symptoms. The dutifulness facet of conscientiousness was negatively associated with re-experiencing symptoms. It is interesting that even though both neuroticism and agreeableness were significantly associated with re-experiencing symptoms, none of the neuroticism or agreeableness facets were found to significantly predict re-experiencing symptoms. The reason for this is unclear, but it may be that the relationship between neuroticism and re-experiencing symptoms as well as between agreeableness and re-experiencing symptoms is driven by the trait as a whole rather than particular facets. It is also interesting that extraversion and openness facets were found to significantly predict re-experiencing symptoms even though the broader traits did not predict re-experiencing symptoms. This highlights the importance of including analyses examining both trait and facet-level relationships.

These results provide important insights into the nature of the relationship between personality and re-experiencing symptoms. Specifically, it appears that there is a

positive relationship between more activating facets including the activity facet of extraversion, the liberal facet of openness, the achievement-striving facet of conscientiousness and the re-experiencing symptom cluster. There are several potential explanations for these findings. One possible reason why more activating personality traits are associated with higher levels of re-experiencing symptoms could be that people with higher activity levels may have poorer coping skills, and may cope by distracting oneself with other activities. Therefore, upon encountering a traumatic event, these individuals may lack the emotional resources necessary to adequately cope with this stressor and may be more likely to develop re-experiencing symptoms. This potential relationship has not previously been well-studied and represents an area of further investigation.

It is also possible that these facets (e.g., activity, achievement-striving) reflect a vulnerability factor whereby adequate attention is not devoted to self-care and/or emotional processing. Rather, people reporting higher levels of these facets may be more inclined to attempt to "push through" negative events and/or may not have taken the time necessary to process and cope with their traumatic experience following the event. Insufficiently processed traumatic information may result in a higher level of re-experiencing symptoms since the trauma is not safely placed within a historical context and the individual has not been able to transfer sensory triggers into verbally accessible and autobiographical information.

Another possible explanation is that some third variable is responsible for the observed association. For example, it is possible that people who score higher on the activity and/or achievement-striving facets, are more likely to be continuously triggered

by environmental stimuli as a function of increased exposure to environmental stimuli. Specifically, individuals who report higher activity levels (e.g., "I am always busy," "I am always on the go") as well as individuals higher in these conscientiousness facets and the liberal facet may be more likely to continue engaging in triggering activities, thereby experiencing a higher degree of re-experiencing symptoms. For example, individuals who score higher in achievement-striving may be less likely to avoid class, even though being in a large group is triggering. They may, therefore, endure these triggering activities while attempting to engage in cognitive avoidance strategies to cope.

Although conscientiousness is generally considered to be a more "positive" and "desirable" trait, it appears that higher levels of conscientiousness are associated with development or expression of re-experiencing symptoms. One potential explanation is that individuals at the higher end of the conscientiousness spectrum may identify themselves as "perfectionists." Therefore, the mere fact that they were exposed to a traumatic event and/or experienced the emotional difficulty that inevitably follows trauma exposure may create difficulties in terms of assimilating the event and/or their emotional difficulties with their self-perception. Therefore, they may be especially likely to develop difficulties when attempting to manage their trauma experience, which may then increase the severity of re-experiencing symptoms. Previous research has found a significantly positive relationship between perfectionism and PTSD symptoms (Egan, Hattaway, & Kane, 2014).

Another interesting finding is that the personality trait of agreeableness and the dutifulness facet of conscientiousness are significantly negatively associated with re-experiencing symptoms. It is possible that these findings simply reflect the symptom

presentation often observed in individuals with PTSD symptoms. Specifically, individuals with higher levels of re-experiencing symptoms may be more likely to have experienced a traumatic event with an interpersonal component (e.g., rape, violence, combat). Therefore, lack of trust toward others is a characteristic feature of PTSD that may be reflected in lower levels of agreeableness. Additionally, this relationship could be the result of re-experiencing symptoms reducing an individual's social interactions to such an extent that they perceive themselves as being "unfriendly", as feeling uncomfortable in social interactions, and as being difficult to get to know.

Another possible explanation is that higher levels of agreeableness and dutifulness serve as protective factors and lower levels serve as vulnerability factors for the development of PTSD. Individuals with lower levels of agreeableness prior to trauma exposure, for example, may be less likely to develop a social support network (Zhu, Woo, Porter, & Brzezinski, 2013) that could mitigate the negative effects of trauma exposure. Therefore, higher premorbid levels of agreeableness may serve as a protective factor in the sense that it facilitates the development of a social support system, increases perceived social support, and may increase people's likelihood of accessing their support system after encountering a traumatic event. For example, it is possible that an individual with a stable and trusted social support system is able to engage in the process of fear extinction and then to recall fear extinction at the prompting of their support system, thereby facilitating continued exposure to feared stimuli and encouraging optimal OFC performance. Similarly, resilience is comprised of a variety of qualities including interpersonal skills, adaptability, and humor, all of which share many similarities with the personality trait of agreeableness (Connor, Davidson, & Lee, 2003). Therefore, it may be

that people with higher levels of agreeableness are more resilient and so exhibit lower levels of PTSD symptoms.

On the other hand, it is possible that regardless of premorbid levels of agreeableness, once people develop PTSD, their level of this personality characteristic decreases as a function of reduced trust in and cooperation with others that commonly follows exposure to a traumatic event (especially ones that occurred within an interpersonal context). Similarly, it is also possible that the development of re-experiencing symptoms decreases the level of this prosocial trait as attention begins to focus inward on internal experiences and outwards towards any indication of threat/danger. These individuals may then become less sensitive to the thoughts/feelings/behaviors of others.

One important factor to consider in the discussion of the relationship between prosocial personality features and PTSD symptoms is the type of traumatic stressor encountered by an individual. Many individuals experience multiple traumas, sometimes beginning early in life. In these cases, it is difficult to discuss premorbid levels of a personality trait compared to post-trauma levels of a personality trait, since the psychological impact of the traumatic experience(s) from early in life may be the guiding force of personality development. An individual who experienced multiple episodes of childhood abuse, for example, may exhibit lower levels of agreeableness as a result of the type of abuse experienced, the age(s) at which the abuse was experienced, and the duration of the abuse. In these types of situations, it is therefore impossible to determine premorbid levels of a personality trait. However, an understanding of current personality traits, whether or not they reflect the premorbid personality constellation, can still provide

important information about an individual's ability to cope in the event that are exposed to continued traumatic stressors later in life.

Overall, therefore, these exploratory analyses highlight several areas regarding the relationship between personality and PTSD symptoms that merit further investigation in order to inform potential prevention/intervention strategies.

Chapter V: Limitations

There are several limitations to this study, including the potential that the "Sniffin' Sticks" may have been limited in its ability to detect an effect between OI, personality, and PTSD symptoms by its relative brevity and by its inability to differentiate between pleasant and unpleasant odors. This finding does, however, represent a contribution to the field, since no previous research using the "Sniffin' Sticks" identified limitations related to utilization of this task. Future researchers may therefore want to be cautious in their use of the "Sniffin' Sticks."

Another limitation is that the descriptive nature of this study prevents the discussion of causal relationships. Specifically, this study does not allow conclusions to be drawn regarding the nature of the relationship between personality traits/facets, PTSD symptoms, and OFC functioning. It is impossible to determine how these variables interact to influence one another. It is possible structural and/or functional variations in the OFC serve as a precursor for the development of specific personality traits and as protective or vulnerability factors for the development of PTSD. It is also possible that variations in the structure/function of the OFC are independent from variations in personality traits, and that the two separately contribute to PTSD development, maintenance, and/or manifestation. It is also possible that early exposure to PTSD leads to the development of certain personality traits and leads to neurological changes in the OFC or that trauma exposure, regardless of the age at which the exposure occurred, leads to neurological and/or personality changes. This study is unable to answer these questions, but does provide important information that can be useful for future longitudinal studies designed to address these issues.

Lastly, utilization of the college population made it difficult to separate individuals by type and number of traumatic experiences, which further limits discussion of the meaning of the findings. It is very likely that the age at which trauma exposure occurred, the number of trauma exposures, and the frequency of trauma exposures have an impact on neurological structure/function as well as on the development and manifestation of personality traits. However, the use of the college student population enabled generalization of results beyond the combat veteran population. Similarly, the college student population is likely a more representative sample of the general population than is the combat veteran population.

Chapter VI: Future Directions

Future research should utilize an olfactory identification task with a greater number of items and an ability to measure differences between identification of pleasant versus unpleasant odors. Using a test with the ability to measure differences between pleasant and unpleasant odors may increase the likelihood that a relationship between PTSD and OFC functioning as well as between personality traits/facets and OFC functioning can be determined.

Future research should also evaluate differences by type and number of trauma exposures as well as age at first trauma exposure. Exploring the relationship between these variables, OFC functioning, and personality traits could provide important insights into how these variables influence personality and neurological development. Additionally, future research could explore the manner in which OFC functioning and/or olfactory sensitivity may mediate the relationship between personality and re-experiencing symptoms.

Another interesting direction for future research would involve longitudinal research assessing Big Five personality traits and PTSD symptoms in order to differentiate personality factors that serve as vulnerability/protective factors from those that occur as a result of PTSD symptoms.

Chapter VII: Conclusion

Overall, these results suggest the need for further research geared toward identifying potential risk and protective factors for the development of PTSD, as well as the potential impact of trauma on one's personality constellation. Regarding OFC functioning, it appears that although total PTSD symptoms were not significantly associated with olfactory sensitivity, the re-experiencing symptom cluster of PTSD was negatively associated with olfactory sensitivity. Additionally, the anxiety facet of neuroticism was significantly positively associated with olfactory sensitivity. This would suggest that the anxiety facet of neuroticism is also related to re-experiencing symptoms. However, this was not the case. In fact, none of the neuroticism facets were significantly related to the re-experiencing symptom cluster in these analyses even though the neuroticism trait as a whole was related to re-experiencing symptoms. Therefore the potential relationship between the anxiety facet of neuroticism and the re-experiencing symptom cluster of PTSD remains unclear.

The positive relationship observed between the conscientiousness trait, the activity facet of extraversion, the liberal facet of openness, the achievement-striving facet of conscientiousness and re-experiencing symptoms as well as the negative relationship between agreeableness and re-experiencing symptoms highlight important areas for future research geared toward identifying potential prevention/intervention strategies based on personality traits/facets.

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Table 1

Descriptive statistics for unstandardized variables of interest

	Minimum	Maximum	Mean	SD	Median
OI	6	16	13.51	1.67	14
Total PTSD	17	80	35.46	13.12	34
Total LSC	0	19	6.49	4.09	5
Neuroticism	1.78	4.57	2.89	.58	2.88
Extraversion	2.03	4.55	3.35	.52	3.38
Agreeableness	2.43	4.42	3.58	.42	3.63
Conscientious	2.78	4.68	3.64	.39	3.65
Openness	2.47	4.28	3.42	.36	3.4
ReexperiencingSx	5	23	10.42	4.26	10
AvoidanceSx	3	15	6.36	3.03	6
NumbingSx	4	20	7.71	3.91	7
HyperarousalSx	5	24	10.98	4.53	11
Age	18	52	25.45	7.01	24
Manic Sx	5	24	11.90	4.10	11
Depressive Sx	8	25	17.60	3.62	18
Anxiety Sx	7	28	20.01	4.59	20

Note. N = 107

Table 2

Correlation matrix examining correlations between all variables of interest

	Neurot	Total PTSD	RexprncSx	Avoid Sx	Numb Sx	Hyper Sx	Agreeable	Conscient	Open	Extravert
Neurot	1	.57**	.48**	.34**	.57**	.50**	-.11	-.47**	-.02	-.66**
TotlPTSD	.57**	1	.84**	.76**	.87**	.85**	-.24*	-.19*	-.02	-.50**
RexprncSx	.48**	.84**	1	.62**	.64**	.54**	-.15	-.07	.08	-.33**
AvoidSx	.34**	.76**	.62**	1	.54**	.50**	-.07	-.01	-.05	-.37**
NumbSx	.57**	.87**	.64**	.54**	1	.71**	-.24*	-.22*	-.03	-.53**
HyperSx	.51**	.85**	.54**	.50**	.71**	1	-.30**	-.30**	-.09	-.42**
Agreeable	-.01	-.24*	-.16	-.07	-.24*	-.30**	1	.40**	.16	.09
Conscientious	-.47**	-.19*	-.07	-.01	-.22*	-.30**	.40**	1	.14	.26**
Openness	-.02	-.02	.08	-.05	-.03	-.09	.16	.14	1	.18
Extraversion	-.66**	-.50**	-.33**	-.37**	-.53**	-.42**	.09	.26**	.18	1
Age	0.03	.30**	.22*	.22*	.26**	.29**	.04	-.10	-.16	-.18
Manic Sx	-.39**	-0.19	-0.10	-0.18	-.11	-.23*	-.07	.18	.07	.43**
Depression	-.70**	-.64**	-.45**	-.32**	-.70**	-.59**	.19*	.38**	-.10	.58**
Anxiety	-.73**	-.64**	-.53**	-.34**	-.58**	-.63**	.20*	.25*	.02	.50**
Schizophrenia	-	-	-	-	-	-	-	-	-	-
# of Head Injuries	.01	.23*	.15	.12	.15	.31**	-.08	-.03	-.04	.01
TBI Score	.09	-.04	-.02	-.03	-.01	-.08	.14	.03	-.02	-.21
Brain Injury	-.20	-.01	.02	.10	-.08	-.03	-.11	-.03	-.01	.02
NAART IQ	.08	.16	.10	.03	.19*	.19	.05	.07	.15	-.19*
Gender	.14	-.05	0.03	.04	-.05	-.14	.33**	.12	.17	.09
OI	.10	-.02	-.14	-.08	.03	.09	.05	.03	-.06	.01

Table 2

Correlation matrix examining all variables of interest, continued

	Age	Mania	Depress	Anxiety	Schiz	Head Injury	TBI	Brain Damage	NAART	Gender	OI
Neuroticism	.03	-.39**	-.70**	-.73**	-	.01	.09	-.02	.08	.14	.10
Total PTSD	.30**	-.19	-.64**	-.64**	--	.23*	-.04	-.01	.16	-.05	-.02
RexprncSx	.22*	-.10	-.45**	-.53**	-	.15	-.02	.02	.10	.03	-.14
AvoidSx	.22*	-.18	-.32**	-.34**	-	.12	-.03	.10	.03	.04	-.08
NumbSx	.26**	-.11	-.70**	-.58**	-	.15	-.01	-.08	.19*	-.05	.03
HyperSx	.29**	-.23*	-.59**	-.63**	-	.31**	-.08	-.03	.19	-.14	.09
Agreeableness	.04	-.07	.19*	.20*	-	-.08	.14	-.11	.05	.33**	.05
Conscientious	-.11	.18	.38**	.25*	-	-.03	.03	-.03	.07	.12	.03
Openness	-.16	.07	-.11	.02	-	-.04	-.02	-.01	.15	.17	-.06
Extraversion	-.18	.43**	.58**	.50**	-	.01	-.21*	.02	-.19*	.09	.01
Age	1	-.23*	-.25*	-.08	-	.04	.06	-.05	.27**	-.23*	.20*
Mania	-.21*	1	.28**	.21*	-	.09	-.17	.07	-.20*	.002	-.20*
DepressiveSx	-.25*	.28**	1	.73**	-	-.10	-.02	.09	-.16	.01	-.10
AnxietySx	-.08	.21*	.73**	1	-	-.20*	.07	-.03	-.02	.01	-.04
Schizophrenia	-	-	-	-	-	-	-	-	-	-	-
Head Injury	.04	.09	-.10	-.20*	-	1	-.45*	.28**	.05	-.21*	.03
TBI	.06	-.17	-.02	.07	-	-.45**	1	-.12	.09	.14	-.14
Brain Damage	-.05	.07	.09	-.03	-	.28**	-.12	1	-.16	-.03	-.17
NAART	.27**	-.20*	-.16	-.02	-	.05	.09	-.16	1	-.12	.08
Gender	-.23*	.00	.01	.01	-	-.21*	.14	-.03	-.12	1	.06
OI	.20*	-.20*	-.10	-.04	-	.03	-.14	-.17	.08	.06	1

Note: Sx = symptoms, Neurot = Neuroticism, RexprncSx = Re-experiencing Symptoms, AvoidSx = Avoidance Symptoms, NumbSx = Numbing symptoms, HyperSx = Hyperarousal symptoms, Agreeable = Agreeableness, Conscient = Conscientiousness, Open = Openness, Extravert = Extraversion, Depress = Depressive symptoms, Schiz = Schizophrenia diagnosis, TBI = Traumatic Brain Injury, Gend = Gender (males were coded as 1, females were coded as 2), NAART = North American Adult Reading Test, OI = Olfactory Identification

Table 3

Hierarchical regressions testing the relationship between neuroticism, extraversion, and olfactory sensitivity

	Neuroticism		Extraversion	
Predictors	ΔR^2	β	ΔR^2	β
Step 1	.06*		.06*	
Mania		-.16		-.16
Age		.16		.16
Step 2	.001		.013	
Mania		-.15		-.22*
Age		.16		.17
Personality Trait		.04		.13

Note. N = 106, * $p < .05$.

Table 4

Hierarchical regressions testing total PTSD symptoms, PTSD symptom clusters, and olfactory sensitivity

	Total PTSD		Symptom Clusters		Reexperiencing	
Predictors	ΔR^2	β	ΔR^2	β	ΔR^2	β
Step 1	.06*		.06*		.06*	
Mania		-.16		-.16		-.16
Age		.16		.16		.16
Step 2	.01		.05		.04*	
Mania		-.18		-.15		-.17
Age		.19		.18		.20*
Total PTSD		-.11		--		--
Reexperiencing Symptoms		--		-.26		-.20*
Hyperarousal Symptoms		--		.16		--
Avoidance/Numbing Symptoms		--		-.02		--

Note. N = 106, * $p < .05$.

Table 5

Hierarchical regressions testing interactions between personality and total PTSD symptoms in predicting olfactory sensitivity

	Neuroticism		Extraversion	
Predictors	ΔR^2	β	ΔR^2	β
Step 1	.06*		.06*	
Mania		-.16		-.16
Age		.16		.16
Step 2	.001		.01	
Mania		-.11		-.23*
Age		.24*		.18
Total PTSD		-.18		-.11
Personality Trait		.18		.10
Personality Trait x PTSD		-.11		-.09

Note. N = 106, * $p < .05$.

Table 6

Hierarchical regression testing the three-way interaction between neuroticism, extraversion, and total PTSD symptoms in predicting olfactory sensitivity

	ΔR^2	β
Predictors		
Step 1	.06*	
Mania		-.16
Age		.16
Step 2	.001	
Mania		-.17
Age		.24*
Total PTSD		-.19
Neuroticism		.27
Extraversion		.22
PTSD*Neuroticism *Extraversion		-.03

Note. N = 106, * $p < .05$.

Table 7

Hierarchical regressions testing the interaction between personality traits and re-experiencing symptoms in predicting olfactory sensitivity

	Neuroticism		Extraversion	
Predictors	ΔR^2	β	ΔR^2	β
Step 1	.06*		.06*	
Mania		-.16		-.16
Age		.16		.16
Step 2	.07		.01	
Mania		-.09		-.22*
Age		.24*		.20*
Re-experiencing Symptoms		-.26*		-.20*
Personality Trait		.21		.07
Personality Trait x Re-experiencing Symptoms		-.10		-.09

Note. N = 106, * $p < .05$.

Table 8

Hierarchical regression testing the three-way interaction between neuroticism, extraversion, and re-experiencing symptoms in predicting olfactory sensitivity

	ΔR^2	β
Predictors		
Step 1	.06*	
Mania		-.16
Age		.16
Step 2	.10*	
Mania		-.16
Age		.27*
Re-experiencing Symptoms		-.32*
Neuroticism		.34*
Extraversion		.28
Reexperiencing* Neuroticism* Extraversion		-.06

Note. N = 106, * $p < .05$.

Table 9

Hierarchical regression testing the relationship between all Big Five traits and re-experiencing symptoms in predicting olfactory sensitivity

Predictors	ΔR^2	β
Step 1	.06*	
Mania		-.16
Age		.16
Step 2	.14*	
Mania		-.14
Age		.31*
Re-experiencing Symptoms		-.37*
Neuroticism		.52*
Conscientiousness		.27*
Openness		-.04
Extraversion		.29*
Agreeableness		-.11

Note. N = 106, * $p < .05$.

Table 10

Hierarchical regressions testing the relationship between neuroticism facets and all DV's

	OI		TotlPTSD		RexprncSx		AvoidSx		NumbSx		HyperSx	
Predictors	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β
Step 1	.06*		.51*		.32*		--		.50*		.46*	
Mania		-.16		.03		--		--		--		--
Anxiety Symptoms		--		-.43*		-.52*		--		--		-.61*
Depressive Symptoms		--		-.28*		--		--		-.70*		--
Age		.16		.21*		.18*		--		--		.25*
Step 2	.09		.05*		.07		--		.05*		.11*	
Mania		-.10		.03		--		--		--		--
AnxietySx		--		-.36*		-.33*		--		--		-.54*
DepressiveSx		--		-.26*		--		--		-.66*		--
Age		.19		.21*		.16		--		--		.16*
Anger		-.06		-22*		.19		.01		.22*		.10
Anxiety		.44*		--		.09		.10		-.10		-.09
Depression		-.11		--		.18		.35*		--		.36*
Immoderation		.05		-.03		-.07		-.05		-.09		.05
Self-Consciousness		.01		-.15		-.16		-.17		-.11		-.26*
Vulnerability		-.22		.10		.02		.11		.13		-.09

Note. N = 106, * $p < .05$.

Table 11

Hierarchical regressions testing the relationship between extraversion facets and all DV's

	OI		TotlPTSD		RexprncSx		AvoidSx		NumbSx		HyperSx	
Predictors	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β
Step 1	.06*		.51*		.32*		--		.50*		.46*	
Mania		-.16		.03		--		--		--		--
Anxiety Symptoms		--		-.43*		-.52*		--		--		-.61*
Depressive Symptoms		--		-.28*		--		--		-.70*		--
Age		.16		.21*		.18*		--		--		.25*
Step 2	.05		.10*		.10*		--		.05*		.08*	
Mania		-.21		.05		--		--		--		--
Anxiety Symptoms		--		-.30*		-.45*		--		--		-.44*
Depressive Symptoms		--		-.25*		--		--		-.66*		--
Age		.13		.12		.11		--		--		.19*
Activity		.16		-22*		.29*		.18		.22*		.09
Assertiveness		.06		.08		-.04		.14		-.10		.12
Cheerfulness		.07		-.14		-.08		-.01		--		-.19
Excitement-Seeking		-.15		.02		.02		-.08		-.09		.19*
Friendliness		-.07		-.27*		-.24		-.44*		-.11		-.15
Gregariousness		.12		-.05		.08		-.14		.13		-.17

Note. N =106, * $p < .05$.

Table 12

Hierarchical regressions testing the relationship between agreeableness facets and all DV's

	OI		TotlPTSD		RexprncSx		AvoidSx		NumbSx		HyperSx	
Predictors	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β
Step 1	.06*		.51*		.32*		--		.50*		.46*	
Mania		-.16		.03		--		--		--		--
Anxiety Symptoms		--		-.43*		-.52*		--		--		-.61*
Depressive Symptoms		--		-.28*		--		--		-.70*		--
Age		.16		.21*		.18*		--		--		.25*
Step 2	.02		.06*		.02		--		.06		.10*	
Mania		-.14		.07		--		--		--		--
Anxiety Symptoms		--		-.44*		-.50*		--		--		-.52*
Depressive Symptoms		--		-.17		--		--		-.62*		--
Age		.16		.23*		.19*		--		--		.25*
Altruism		.10		-.10		-.05		-.14		-.17		-.04
Cooperativeness		.04		-.27*		-.13		-.14		-.20*		-.35*
Modesty		-.06		.03		.05		.15		-.03		.02
Morality		.10		.14		-.02		.10		.17		.14
Sympathy		-.04		.09		.03		.14		.07		.05
Trust		-.16		-.03		.08		-.16		.01		-.08

Note. N = 106, * $p < .05$.

Table 13

Hierarchical regressions testing the relationship between conscientiousness facets and all DV's

	OI		TotlPTSD		RexprncSx		AvoidSx		NumbSx		HyperSx	
Predictors	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β
Step 1	.06*		.51*		.32*		--		.50*		.46*	
Mania		-.16		.03		--		--		--		--
Anxiety Symptoms		--		-.43*		-.52*		--		--		-.61*
Depressive Symptoms		--		-.28*		--		--		-.70*		--
Age		.16		.21*		.18*		--		--		.25*
Step 2	.03		.03		.08		--		.02		.05	
Mania		-.20		.001		--		--		--		--
Anxiety Symptoms		--		-.47*		-.60*		--		--		-.59*
Depressive Symptoms		--		-.25*		--		--		-.70*		--
Age		.16		.20*		.18*		--		--		.22*
Achievement-Striving		.11		.16		.25*		.17		.06		.10
Cautiousness		-.10		-.02		.11		-.04		-.10		-.11
Dutifulness		.14		-.11		-.26*		-.03		--		-.11*
Orderliness		.05		.02		-.03		.17		.08		-.01
Self-Discipline		-.09		-.10		-.09		-.13		-.04		-.16
Self-Efficacy		.01		-.08		.12		-.14		.002		.10

Note. N = 106, * $p < .05$.

Table 14

Hierarchical regressions testing the relationship between openness facets and all DV's

	OI		TotlPTSD		RexprncSx		AvoidSx		NumbSx		HyperSx	
Predictors	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β
Step 1	.06*		.51*		.32*		--		.50*		.46*	
Mania		-.16		.03		--		--		--		--
Anxiety Symptoms		--		-.43*		-.52*		--		--		-.61*
Depressive Symptoms		--		-.28*		--		--		-.70*		--
Age		.16		.21*		.18*		--		--		.25*
Step 2	.04		.03		.04		--		.05		.06	
Mania		-.14		.01		--		--		--		--
Anxiety Symptoms		--		-.23*		-.53*		--		--		-.62*
Depressive Symptoms		--		-.45*		--		--		-.68*		--
Age		.18		.18*		.19*		--		--		.22*
Adventurous		-.07		-.03		.10		-.28*		-.15		.04
Artistic Interest		.10		.03		.01		.05		-.03		-.07
Emotion		.03		-.07		.01		.02		-.06		-.17*
Imagination		.04		-.04		-.06		-.05		-.09		.07
Intellect		-.05		.03		.03		.02		.05		-.05
Liberal		-.16		.16*		.16		.16		.11		.16*

Note. N = 106, * $p < .05$.

Table 15

Hierarchical regressions testing the relationship between Big Five traits and all DV's

	OI		TotlPTSD		RexprncSx		AvoidSx		NumbSx		HyperSx	
Predictors	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β
Step 1	.06*		.51*		.32*		--		.50*		.46*	
Mania		-.16		.03		--		--		--		--
Anxiety Symptoms		--		-.43*		-.52*		--		--		-.61*
Depressive Symptoms		--		-.28*		--		--		-.70*		--
Age		.16		.21*		.18*		--		--		.25*
Step 2	.05		.06*		.08		--		.06*		.05	
Mania		-.19		.08		--		--		--		--
Anxiety Symptoms		--		-.25*		-.26*		--		--		-.5*
Depressive Symptoms		--		-.19*		--		--		-.57*		--
Age		.20*		.26*		.26*		--		--		.25*
Neuroticism		.27		.29*		.43*		.27*		.16		.04
Extraversion		.27*		-.10		.07		-.24		-.11		-.08
Conscientious		.16		.19*		.25*		.22		.19*		-.05
Agreeableness		-.02		-.20		-.19*		-.10		-.17*		-.18*
Openness		-.08		.02		.12		-.02		-.07		.01

Note. N = 106, * $p < .05$.

Appendix A

Screening Questionnaire

"I am going to ask you a few questions to determine your eligibility to participate in this study. Please answer yes or no if you have been diagnosed with any of the following. Do not specify what it is you have been diagnosed with. Simply state 'yes' if any of the following apply to you or 'no' if none of them apply to you."

"Organic brain impairment like brain tumor or mass, or epilepsy; history of head injury that resulted in loss of consciousness for thirty minutes or more; a medical condition that has permanently impaired your ability to breathe or smell, or a history of nasal trauma"

If yes to the above,

"Thank you for your interest in this study. Unfortunately you have endorsed a medical condition that makes you ineligible for participation. You will still receive 1 research credit for attending today's session. Thank you again for your time."

If no to the above,

"Do you currently have a medical condition that is temporarily interfering with your ability to breathe or smell, like allergies or a cold?"

If yes to the above, state that we will reschedule in two weeks if the condition has been resolved.

If no to the above, proceed with the research session.

Appendix B

Exploratory Analyses

Exploratory analyses were conducted exploring the relationship between Big Five personality facets, PTSD total scores, and PTSD symptom clusters. First, simple regression analyses were performed to determine whether previously identified potential covariates significantly predicted total PTSD scores. Bivariate regression analyses revealed that several variables significantly predicted PTSD total scores. Namely, manic symptoms (β = -.19, p = .05), age (β = .30, p = .002), depression (β = -.64, p < .001), and anxiety (β = -.64, p < .001) were all significant related to total PTSD scores. These variables were entered into the first step of all following hierarchical regression analyses.

The hierarchical regression model containing the four covariates (age, manic symptoms, depression, and anxiety) in the first step and all six neuroticism facets in the second step demonstrated that as the anger facet of neuroticism increased, PTSD symptoms also increased (β = .22, p = .02; see Table 10). Results also revealed that as the activity facet of extraversion increased, PTSD total scores also increased (β = .22, p = .003; see Table 11). Additionally, as the friendliness facet of extraversion increased, PTSD scores decreased (β = -.27, p = .03). Of the six agreeableness facets, the cooperativeness facet emerged as the only significant predictor (β = -.27, p = .01), such that as cooperativeness increased, PTSD total scores decreased (see Table 12). Lastly, the liberal facet of openness significantly predicted PTSD total scores (β = .16, p = .04; see Table 14). None of the conscientiousness facets significantly predicted PTSD scores (see Table 13).

Exploratory analyses were conducted on the other three PTSD symptom clusters: avoidance symptoms, numbing symptoms, and hyperarousal symptoms. None of the variables previously identified as potential covariates significantly predicted avoidance symptoms. A multiple regression analysis was performed to explore the relationship between the Big Five personality traits and avoidance symptoms. The regression model containing the Big Five traits was found to significantly predict avoidance symptoms ($F(5, 101) = 4.52$, $p = .001$). Neuroticism was the only trait that significantly predicted avoidance symptoms ($\beta = .27$, $p = .05$). Therefore, as levels of neuroticism increased, avoidance symptoms also increased (see Table 15). A regression model containing the six neuroticism facets was found to significantly predict avoidance symptoms ($F(6, 100) = 3.29$, $p = .005$). The depression facet of neuroticism was found to significantly positively predict avoidance symptoms ($\beta = .35$, $p = .02$; see Table 10). The regression model containing the six extraversion facets was found to significantly predict avoidance symptoms ($F(6, 100) = 5.31$, $p < .001$). Specifically, as friendliness increased, avoidance symptoms decreased ($\beta = -.44$, $p = .01$; see Table 11). None of the agreeableness (see Table 12), conscientiousness (see Table 13), or openness facets (see Table 14) significantly predicted avoidance symptoms.

Multiple regression analyses were conducted to identify potential covariates for the hyperarousal symptom cluster. Anxiety ($\beta = -.46$, $p = .00$) and age ($\beta = .203$, $p = .01$) emerged as significant covariates and were therefore included in all further analyses with the hyperarousal symptom cluster. A hierarchical regression analysis was conducted to explore the relationship between the Big Five traits and the hyperarousal symptom cluster while controlling for age and anxiety (see Table 15). Results revealed that the higher a

person is on the agreeableness trait, the less likely they are to endorse hyperarousal symptoms (β = -.18, p = .03).

Hierarchical regression analyses were also conducted to explore the relationship between the Big Five facets and the hyperarousal symptom cluster. Results revealed that as the depression facet of neuroticism increased, hyperarousal symptoms also increased (β = .36, p = .002) and as the self-consciousness facet of neuroticism increased, hyperarousal symptoms decreased (β = -.26, p = .01; see Table 10). Results also revealed that as the excitement-seeking facet of extraversion increased, hyperarousal symptoms also increased (β = .19, p = .03; see Table 11). Within the agreeableness trait, the higher a person's score within the cooperativeness facet, the less likely they were to endorse hyperarousal symptoms (β = -.35, p < .001; see Table 12). Results also revealed that within the openness trait, the more open a person is to their own emotional experience, the less likely they are to report experiencing hyperarousal symptoms (β = -.17, p = .03; see Table 14). Additionally, as liberality increased, hyperarousal symptoms also increased (β = .16, p = .03). None of the conscientiousness facets significantly predicted hyperarousal symptoms (see Table 13).

A multiple regression analysis testing the relationship between potential covariates and numbing symptoms identified depression as the only significant covariate (β = -.57, p < .001). Therefore, as depressive symptoms increased, numbing symptoms decreased. Depression was included as a covariate in all further analyses with numbing symptoms. A hierarchical regression analysis analyzing the relationship between the Big Five Traits and numbing symptoms revealed that agreeableness (β = -.17, p = .02) and conscientiousness (β = .18, p = .03) significantly predicted numbing symptoms (see

Table 15). A hierarchical regression analysis exploring the relationship between neuroticism facets and numbing symptoms revealed that the higher the reported level of anger, the higher the reported numbing symptoms (β = .22, p = .02; see Table 10). Of the extraversion facets, results indicated that as activity level increased, numbing symptoms also increased (β = .18, p = .01); whereas as cheerfulness increased, numbing symptoms decreased (β = -.23, p = .01; see Table 11). Of the agreeableness facets, results revealed that the higher a participant scored on the cooperativeness facet, the less likely they were to report numbing symptoms (β = -.20, p = .03; see Table 12). None of the conscientiousness (see Table 13) or openness facets (see Table 14) significantly predicted numbing symptoms.

Discussion

Total PTSD Symptoms.

Exploratory analyses were conducted to explore the relationship between personality traits/facets and PTSD symptoms. Results of these analyses will initially be categorized and briefly discussed by criterion (e.g., PTSD symptom cluster); then a more comprehensive discussion will be devoted to common patterns and themes that emerged across all analyses. Results revealed that the activity facet of extraversion, the anger facet of neuroticism, and the liberal facet of openness were all significantly positively associated with total PTSD symptoms. Additionally, the friendliness facet of extraversion and the cooperativeness facet of agreeableness were significantly negatively associated with total PTSD symptoms. Overall, therefore, it appears that personality facets that reflect a higher degree of physiological arousal or externalizing behaviors (activity,

anger, liberalness) are associated with higher levels of total PTSD symptoms, while personality facets that reflect more prosociality (friendliness, cooperativeness) are associated with lower levels of total PTSD symptoms.

Avoidance Symptoms.

Results revealed a significant positive relationship between neuroticism and the avoidance symptom cluster. Higher neuroticism scores may reflect a vulnerability factor for the development of avoidance symptoms. Neuroticism can be conceptualized as a tendency to experience negative affect; therefore, individuals who score higher on neuroticism may be more likely to avoid exposure to stimuli perceived as threatening or that are interpreted as having the potential to elicit negative emotions.

On the other hand, the avoidance symptoms characteristic of PTSD may increase neurotic tendencies. Specifically, the development of PTSD in general, and avoidance symptoms in particular, may increase one's tendency to experience negative affect, especially as the avoidance behaviors result in a continuous narrowing of one's world and an absence of reinforcing activities or interactions. Additionally, it is also possible that a mediating variable could include perceived lack of social support. In this case, pre-existing neurotic tendencies may reduce one's perceived sense of social support, which may then increase the likelihood of avoidance behaviors upon encountering a traumatic event.

In addition to the relationship between neuroticism and avoidance symptoms, several personality facets also evidenced a relationship with avoidance symptoms. Specifically, the depression facet of neuroticism was positively associated with avoidance

symptoms, while the friendliness facet of extraversion was negatively associated with avoidance symptoms. These findings suggest that the relationship between neuroticism and avoidance symptoms is primarily driven by the depression facet of neuroticism.

Hyperarousal symptoms.

Results revealed a significant negative relationship between agreeableness and hyperarousal symptoms. Hyperarousal is often conceptualized as occurring as a result of re-experiencing symptoms and associated attempts to avoid these symptoms, which leave the individual hypervigilant and with a high degree of physiological arousal. It appears that the more agreeable people are, the less likely they are to experience this heightened degree of physiological arousal, irritability, and hypervigilance. At the facet level, the excitement-seeking facet of extraversion and the depression facet of neuroticism are both positively related to hyperarousal symptoms. Additionally, the self-consciousness facet of neuroticism, the cooperativeness facet of agreeableness, and the openness to emotions facet of openness are all negatively associated with hyperarousal symptoms. It is interesting to note that two facets, excitement-seeking and depression, that describe very different types of behavior, are both positively associated with hyperarousal symptoms. It seems to make sense that the depression facet of neuroticism is positively associated with hyperarousal symptoms as it is also positively related to avoidance symptoms.

The emotions facet of openness provides interesting insights into the mechanism of many PTSD treatments. Specifically, a stance of openness and willingness toward one's emotional experience is, in essence, a form of emotional exposure. Since hyperarousal symptoms are partially explained by attempts to avoid reminders of the traumatic event in order to avoid their associated emotional response, it would make

sense that a higher level of willingness to experience one's emotions would result in lower levels of hyperarousal. Similarly, an individual who is experiencing higher levels of hyperarousal symptoms may seek to avoid experiencing their emotional responses, therefore reducing their levels of openness to emotions.

Numbing symptoms.

Analyses conducted with the numbing symptom cluster revealed a significant negative relationship with agreeableness and a significant positive relationship with conscientiousness. At the facet-level, results revealed a significant positive relationship between the activity facet of extraversion and the anger facet of neuroticism. They also revealed a negative relationship between the cheerfulness facet of extraversion and the cooperativeness facet of agreeableness. These results are similar to previous results, and are markedly similar to the facets found to significantly correlate with total PTSD symptoms.

Regarding the negative relationship between the cheerfulness and cooperative facets and numbing symptoms, individuals attempting to numb their emotional experience are unable to numb selective emotions. Rather, they become numb to all emotions, positive and negative alike. Therefore, if people are emotionally numb, they are less likely to describe themselves as cheerful. Additionally, cooperativeness is often motivated by and elicits positive emotions. If one does not feel positive emotions and prefers to avoid activities that may elicit positive emotions, that person is less likely to engage in cooperative behaviors, and therefore less likely to describe themself as cooperative.

Overall Themes.

Several patterns emerged from the data examining the relationships between personality traits/facets and PTSD symptoms. One theme involved the overall positive relationship between more activating facets including the activity facet of extraversion, the excitement-seeking facet of extraversion, the anger facet of neuroticism, the liberal facet of openness, and the achievement-striving facet of conscientiousness with total PTSD symptoms, the re-experiencing symptom cluster, the hyperarousal symptom cluster, and the numbing symptom cluster. There are several potential explanations for these findings. One possible reason why personality facets reflecting higher levels of physiological arousal are associated with higher levels of PTSD symptoms is simply that heightened arousal is a characteristic feature of PTSD, including high levels of anger and risk-taking behaviors. Therefore, these findings could simply reflect the symptom picture of PTSD. On the other hand, these findings could reflect personality features that may predispose one to the development of PTSD. For example, an individual with higher levels of anger and higher activity levels may have poorer coping skills, and may cope via externalizing behaviors (e.g., yelling, fighting) and/or by distracting oneself with other activities. Therefore, upon encountering a traumatic event, these individuals may lack the emotional resources necessary to adequately cope with this stressor and may be more likely to develop PTSD.

It is also possible that these facets (e.g., activity, anger, achievement-striving) reflect a vulnerability factor whereby adequate attention is not devoted to self-care and/or emotional processing. Rather, individuals reporting higher levels of these facets may be more inclined to attempt to "push through" negative events and/or may not have taken the

time necessary to process and cope with their traumatic experience following the event. Insufficiently processed traumatic information may result in a higher level of PTSD symptoms (e.g., re-experiencing, numbing, and hyperarousal symptoms) since the trauma is not safely placed within a historical context and the individual has not worked on transferring sensory triggers into verbally accessible and autobiographical information.

Another possible explanation is that some third variable is responsible for the observed association. For example, it is possible that individuals that score higher on the activity, anger, and/or conscientiousness facets, are more likely to be continuously triggered by environmental stimuli as a function of increased exposure to environmental stimuli. Specifically, individuals who report higher activity levels (e.g., "I am always busy," "I am always on the go") as well as individuals higher in these conscientiousness facets and the liberal facet may be more likely to continue engaging in triggering activities, thereby experiencing a higher degree of PTSD symptoms. For example, individuals who score higher in achievement-striving may be less likely to avoid class, even though being in a large group is triggering. They may, therefore, endure these triggering activities while attempting to engage in cognitive avoidance strategies to cope. Alternatively, individuals who are higher in the anger facet may cope with environmental stressors by becoming angry and hostile toward others, and may even prematurely escape the situation, thereby mitigating any therapeutic effects of the exposure.

Although conscientiousness is generally considered to be a more "positive" and "desirable" trait, it appears that higher levels of conscientiousness are associated with development or expression of certain symptom clusters. One potential explanation is that individuals at the higher end of the conscientiousness spectrum may identify themselves

as “perfectionists.” Therefore, the mere fact that they were exposed to a traumatic event and/or experienced the emotional difficulty that inevitably follows trauma exposure may create difficulties in terms of assimilating the event and/or their emotional difficulties with their self-perception. Therefore, they may be especially likely to develop difficulties when attempting to manage their trauma experience. For example, they may attempt to numb all emotional experiences in order to prevent re-experiencing symptoms from occurring, thereby increasing their experience of these symptoms.

Another general pattern is that the depression facet of neuroticism was positively associated with PTSD symptoms - avoidance and hyperasoual symptom clusters in particular. Since hyperaousal symptoms can be conceptualized as partially resulting from persistent attempts to avoid triggering stimuli, it makes sense that this facet is significantly positively associated with both of these symptom clusters. One possible explanation for these relationships is that the hyperarousal and avoidance symptoms of PTSD increase the subjective experience of oneself as generally depressed, potentially due to a lack of reinforcing activities or interactions. Another possible explanation is that people who tend to view themselves as somewhat depressive may be more inclined to engage in avoidance behaviors in general and are therefore very likely to develop avoidance behaviors upon encountering a traumatic stimulus. Therefore, this higher level of depressive tendencies may be conceptualized as either a vulnerability factor for the development of avoidance symptoms, or as a result of avoidance symptoms.

Another general pattern is that the personality trait of agreeableness, and facets including the cooperativeness facet of agreeableness, the friendliness facet of extraversion, the cheerfulness facet of extraversion, the emotions facet of openness, and

the self-consciousness fact of neuroticism are significantly negatively associated with total PTSD symptoms, and symptom clusters including avoidance, hyperarousal, and numbing. Therefore, it appears that personality features containing components of prosociality and/or interpersonal sensitivity are associated with lower levels of PTSD symptoms. It is possible that this finding also simply reflects the symptom presentation often observed in individuals with PTSD symptoms. Specifically, individuals with higher levels of PTSD symptoms are more likely to have experienced a traumatic event with an interpersonal component (e.g., rape, violence, combat). Therefore, lack of trust toward others is a characteristic feature of PTSD that may be reflected in lower levels of cooperativeness and friendliness. Additionally, this relationship could be the result of avoidance behaviors reducing an individual's social interactions to such an extent that they perceive themselves as being "unfriendly", as feeling uncomfortable in social interactions, and as being difficult to get to know.

Another possible explanation is that higher levels of cooperativeness, friendliness, cheerfulness, and openness to emotions serve as protective factors and lower levels serve as vulnerability factors for the development of PTSD. Individuals with lower levels of these facets may be less "resilient" or "hardy" with respect to coping skills. Resilience is comprised of a variety of qualities including interpersonal skills, adaptability, and humor, all of which share many similarities with personality facets of cooperativeness, friendliness, cheerfulness and openness to emotions (Connor, Davidson, & Lee, 2003). Additionally, individuals with lower levels of these facets prior to trauma exposure may be less likely to develop a social support network (Zhu, Woo, Porter, & Brzezinski, 2013) that could mitigate the negative effects of trauma exposure. Therefore, premorbid levels

of more prosocial and/or interpersonally sensitive facets may serve as protective factors in the sense that they facilitate the development of a social support system, increase perceived social support, and may increase individuals' likelihood of accessing their support system after encountering a traumatic event. For example, if an individual has a stable social support system, it would seem logical that that person would be less likely to engage in avoidance behaviors because doing so may interfere with their interpersonal relationships and because their supports may be more likely to insist that they continue to engage in social activities.

It is also possible that the more agreeable, cooperative, friendly, and/or self-conscious people are before they encounter a traumatic event, the less likely they are to exhibit behaviors (e.g., anger outbursts) that are inconsistent with their personality and their values. All of these personality traits/facets contain behavioral tendencies that include a strong sensitivity toward the thoughts, feelings, and behaviors of others. As such, it makes sense that individuals endorsing high levels of these traits/facets are less likely to endorse PTSD symptoms, and particularly those PTSD symptoms that include irritability, hostility, and anger outbursts.

On the other hand, it is possible that regardless of premorbid levels of agreeableness, once people develop PTSD, their levels of these personality characteristics decrease as a function of reduced trust in and cooperation with others that commonly follows exposure to a traumatic event (especially ones that occurred within an interpersonal context). Similarly, it is also possible that the development of PTSD symptoms decrease the level of these prosocial and/or interpersonally sensitive traits and facets as attention begins to focus inward on their own internal experience and outwards

towards any indication of threat/danger. These individuals may then become less sensitive to the thoughts/feelings/behaviors of others, although it would seem logical to conclude that these individuals may not have endorsed very high levels of these facets premorbidly.

One important factor to consider in the discussion of the relationship between prosocial personality features and PTSD symptoms is the type of traumatic stressor encountered by an individual. Many individuals experience multiple traumas, sometimes beginning early in life. In these cases, it is difficult to discuss premorbid levels of a personality trait compared to post-trauma levels of a personality trait, since the psychological impact of the traumatic experience(s) from early in life may be the guiding force of personality development. An individual who experienced multiple episodes of childhood abuse, for example, may exhibit lower levels of agreeableness as a result of the type of abuse experienced, the age(s) at which the abuse was experienced, and the duration of the abuse. In these types of situations, it is therefore impossible to determine premorbid levels of a personality trait. However, an understanding of current personality traits, whether or not they reflect the premorbid personality constellation, can still provide important information about an individual's ability to cope in the event that are exposed to continued traumatic stressors later in life.

Prevention/Intervention Strategies.

Taken together, these results provide some potentially useful information related to prevention and intervention strategies for PTSD. Regarding prevention, it appears that encouraging the development of prosocial behaviors and attitudes, assertive communication of anger, and limiting externalizing behaviors, may facilitate the

development of a social support system, which appears to be a powerful way to prevent the development of PTSD upon exposure to a traumatic event. Personality styles characterized by interpersonal sensitivity and an openness or willingness toward one's emotional experience may provide some protective benefit in the face of exposure to a traumatic event. The nature of these potentially protective factors remain ambiguous, but it may be that individuals with higher levels of these personality traits/facets are more likely to have developed a stable social support system that can not only provide support after experiencing a traumatic event, but can help prevent isolation or withdrawal from life by encouraging people to continue engaging in their typical daily activities and to process emotions/symptoms as they arise. It may also be that individuals with premorbidly higher levels of these traits/facets, even if they do experience a decrease in their level of these characteristics immediately following traumatic exposure, either experience a less pronounced decrement, or are less likely to maintain distrust and hostility toward others than are individuals with premorbidly lower levels of these traits/facets.

Regarding intervention, since we know that exposure is a central component of treating PTSD, the presence of a strong social support system and higher levels of friendliness may increase the likelihood that individuals continue to expose themselves cognitively and physically to feared stimuli. Therefore, it may be beneficial for intervention strategies to include an interpersonal component (e.g., group treatment, interpersonal skills training) in order to maximize effectiveness. Additionally, the negative relationship observed between the emotions facet of openness and hyperarousal symptoms lends support to the current emphasis on exposure in evidence-based PTSD

treatments. Whether the focus of treatment is on exposing an individual to feared environmental stimuli, feared thoughts/memories, or feared emotions, these results suggest that teaching an attitude of openness and willingness to experience emotions – positive and negative – may be very beneficial.

Conclusions

Overall, these results paint an interesting picture of potential risk and protective factors for the development of PTSD, as well as the potential impact of trauma on one's personality constellation. Regarding potential protective factors, personality traits and facets that include a component of prosociality and/or interpersonal sensitivity are negatively associated with PTSD symptoms. Traits like agreeableness, and facets including the cooperativeness facet of agreeableness, the friendliness facet of extraversion, the cheerfulness facet of extraversion, and the self-consciousness facet of neuroticism, were all associated with lower levels of total PTSD symptoms and/or one or more PTSD symptom clusters. This suggests that possessing a higher premorbid level of interpersonal sensitivity may mitigate the negative effects of trauma exposure. This could be the case for a number of reasons. One potential explanation is that individuals higher on these personality traits/facets may be more likely to have established a stable social support system that is able to help them manage the deleterious effects of trauma exposure. A support system may, for instance, help the individual process their traumatic experience, provide the emotional support necessary for recovery following trauma exposure, and may encourage continued engagement - both behaviorally and emotionally - in social activities.

Another possible explanation is that individuals who report higher levels of these characteristics may be less likely to develop particular symptoms (e.g., anger, irritability, emotional numbing) that they may perceive as being inconsistent with their self-concept. Additionally, individuals with higher levels of these personality traits may be less likely to have experienced multiple traumas, and especially multiple traumas occurring early in life. Therefore, these individuals may have a learning history that makes them more likely to appropriately attribute the traumatic event to external forces and to more adequately process their emotional experience following trauma exposure than are individuals who have experienced multiple traumas beginning early in life.

Lastly, these personality features may, at least partially, comprise the construct known as "resiliency." Resilience is thought to consist of a variety of qualities that serve to enhance a person's ability to survive adversity. These qualities include adaptability, social skills, and humor, among others (Connor, Davidson, & Lee, 2003). These qualities share many similarities with the traits found to be negatively associated with PTSD in this study. To the extent that these personality facets comprise resiliency, they may indeed serve as protective factors against the development of PTSD.

Taken together, these results provide important insights into potential prevention and/or intervention strategies for PTSD. Specifically, these results suggest that encouraging the development of personality characteristics that contain a more prosocial component and/or an aspect of interpersonal sensitivity may contribute to protecting individuals from development of PTSD. Regarding intervention, these results speak to the value of incorporating group interventions to the treatment of PTSD. Additionally, teaching children how to tolerate negative emotions and how to prioritize self-care,

particularly as it relates to processing negative experiences at an early age, may equip them with the skills necessary to cope with trauma exposure without developing PTSD. The relationship between conscientiousness and PTSD symptoms was unexpected, and may highlight the necessity of teaching people to prioritize their own self-care, even over other goal-oriented activities. Regarding intervention, these findings support the current method of trauma-focused treatments that include the development of self-care, distress tolerance, and openness to the experience of negative emotions. Whether these findings reflect the impact of trauma on personality, factors that impact the development of PTSD, or both, these results provide interesting insights into PTSD and into the potential mechanisms for the efficacy of interventions as well as ideas for prevention.

Appendix C

Publication-Ready Literature Review

Rates of Posttraumatic Stress Disorder (PTSD) among college students are estimated to be 8-9% (Frazier et al., 2009; Read, Ouimet, White, Colder, Farrow, 2011). This is similar to the estimated 8% prevalence of PTSD within community samples (APA, 2000). However, lifetime prevalence of exposure to traumatic experiences among undergraduate college students is estimated to be between 67% and 85% (Frazier et al., 2009; Moser, Hajack, Simons, & Foa, 2007). This is compared to the lifetime rate of exposure to traumatic events in the general population estimated to be 21% (Perrin, Vandeleur, Castelao, Rothen, Glaus, 2014). Therefore, undergraduate college students report high rates of exposure to traumatic events throughout their tenure in college as compared to the rates reported by the general population. However, these data also indicate that the majority of individuals who are exposed to traumatic events do not go on to develop PTSD. This suggests the need for further research geared towards the identification of the determinants of PTSD development in order to inform prevention and/or intervention strategies.

It has long been recognized that a relatively small percentage of individuals who experience a traumatic event go on to develop PTSD. Research has identified several factors that are associated with PTSD development following trauma exposure, including gender, type of traumatic exposure, and preexisting psychopathology (Brewin, Andrews, & Valentine, 2000; Ozer, Best, Lipsey, & Weiss, 2008; Perrin et al., 2014). Other, more dynamic factors have also been identified, including perceived social support (Brewin, Andrews, & Valentine, 2000; Ozer, Best, Lipsey, & Weiss, 2008), global self-esteem

(Adams & Boscarino, 2006; Sutker, Corrigan, Sundgaard-Riise, Uddo, & Allain, 2002), "hardiness" (Whealin, Ruzek, Southwick, 2008), and coping strategies (Perrin et al., 2014; Schnider, Elhai, & Gray, 2007). However, one weakness of the PTSD literature is that there is very little translational research between different disciplines within psychology. As a result, researchers within the various subdisciplines of psychology often appear to be studying similar constructs under different names. This makes it difficult to integrate research findings across disciplines and to draw conclusions from this research. Translational research is critical in its potential to integrate research findings across disciplines and to reveal possible explanations for why one person develops PTSD upon exposure to a traumatic event while another person does not. Personality research, in particular, may be able to bridge the gap between subdisciplines of psychology, and may provide interesting insights into the development and maintenance of PTSD.

Personality is a central component of the human experience. It influences a person's perception of the environment and it shapes the manner in which individuals behave in their environment. Therefore, personality may have a greater impact on the development, maintenance, and topography of PTSD symptoms than has been previously hypothesized. Although research abounds that relates the Big Five personality traits to various pathological states, both in terms of mental and physical illness (e.g. Lonnqvist et al., 2009), very little empirical study has been devoted to linking the Big Five personality traits to PTSD in particular. Several studies have found a relationship between Neuroticism and PTSD such that higher levels of neuroticism were associated with a greater likelihood of being diagnosed with PTSD (Cox, MacPherson, Enns, &

McWilliams, 2004; Perrin et al., 2014). However, these studies have only included very brief assessments of neuroticism, and they have not included assessments of the other four personality traits. Assessment of all five distinct traits is necessary in order to fully understand the nature of the relationship between personality and PTSD. Further, research has not extended beyond traits to include personality facets, which contain more precise descriptive information and may have more predictive potential than do broader traits. Additionally, research has not yet attempted to explore potential relationships between personality traits, personality facets, and specific PTSD symptom clusters. Exploration of the relationship between personality traits, personality facets, and specific PTSD symptom clusters is important in that it may provide important information about the heterogeneity of symptom presentation, symptom development and/or maintenance, and intervention strategies.

Although the full nature of the relationship between PTSD and personality has not yet been thoroughly explored, factors like perceived social support, coping strategies, and "hardiness" have been found to significantly predict the development of PTSD. However, research does not address the issue of what impacts these factors. It is possible that personality traits are the superordinate constructs that impact some of the factors found to predict PTSD development. For example, low perceived social support was found to be the strongest predictor of PTSD development in two meta-analyses (Brewin, Andrews, & Valentine, 2000; Ozer, Best, Lipsey, & Weiss, 2008). It would make sense that extraversion may play a role in the extent to which a person seeks to actively develop social relationships and may then impact perceived social support. Personality theory

could therefore hold valuable information regarding vulnerability to the development of PTSD as well as potential prevention or intervention strategies for the disorder.

Neurological factors are also thought to be associated with the development and maintenance of PTSD symptoms. Exposure to extreme stress has been hypothesized to impact brain regions such as the hippocampus, amygdala, and prefrontal cortex (Brewin, 2001a; 2001b), which are critical to attention, encoding, and memory storage. The orbitofrontal cortex (OFC) is one region within the prefrontal cortex that has been hypothesized to be involved in PTSD. The OFC is thought to play a role in the extinction of learned fear responses (Kühn, Schubert, Gallinat, 2011) and has recently emerged from research on Vietnam War veterans as a prefrontal region that is relevant to both personality characteristics and traumatic symptoms (e.g., Dileo et al., 2007; Vasterling et al., 2000). The specific aims of this study are therefore to examine the (a) relationship between personality traits and OFC functioning (as measured by olfactory sensitivity), (b) relationship between PTSD symptoms and OFC functioning, (c) interaction of PTSD symptoms and personality to predict OFC functioning, and (d) to explore potential relationships between personality traits or facets with specific PTSD symptom clusters. This study will utilize an undergraduate college student population. One important rationale for using college students is that the only research utilizing olfactory identification tasks to examine the role of the OFC in the development and/or maintenance of PTSD symptoms has used a Vietnam War Veteran sample. These findings therefore have the potential to extend findings related to OFC functioning to a civilian population. This study will also begin to address a gap in the literature regarding the absence of translational research between clinical and personality psychology.

Specifically, the identification of a relationship between personality traits/facets and PTSD symptom clusters will be a novel contribution to the field.

Posttraumatic Stress Disorder (PTSD)

What is PTSD?

The fourth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV; American Psychiatric Association [APA], 2000) classified posttraumatic stress disorder (PTSD) as an anxiety disorder that occurs after an individual is exposed to a traumatic stressor in which 1) the person experienced, witnessed, or was confronted with an event that involved actual or threatened death or serious injury or a threat to the physical integrity of self or others and 2) the response to the event involved intense fear, helplessness, or horror. The likelihood of developing PTSD and the severity of the disorder, if present, are partially determined by a number of factors. The disorder may be especially severe or long-lasting if the traumatic event was of human design (e.g., torture, rape) versus a natural disaster (APA, 2000). The likelihood of developing the disorder also increases as the intensity of and physical proximity to the stressor increases (APA, 2000).

The core issue of PTSD is that the experience of and information related to the traumatic event cannot be integrated into autobiographical memory (van der Kolk & McFarlane, 1996). The hallmark symptoms of PTSD include persistently reexperiencing the traumatic event, persistent avoidance of stimuli associated with the traumatic event, numbing of general responsiveness, and persistent symptoms of increased arousal (APA, 2000). These symptoms must have been present for more than one month and they must cause clinically significant distress or impairment in an important area of functioning.

The development and maintenance of PTSD symptoms involves extensive fear conditioning, a process that has strong neurological associations (Brewin, 2001a; 2001b). PTSD is associated with a dysfunctional neurocircuit. The following section reviews potential neurological correlates.

Neurological processes.

The major neurological process underlying PTSD is thought to be a dysfunctional circuit between the frontal lobes and the limbic system. Research suggests that the symptom presentation in PTSD primarily results from a hypersensitive amygdala, and frontal lobes that are incapable of diffusing amygdala activation when the threat stimulus is not actually a threat (Brewin, 2001a; 2001b; Cardenas, 2011). Additionally, hippocampal dysfunction leads to memory deficits and difficulties identifying safe contexts (Brewin, 2001a; 2001b; Cardenas, 2011). In individuals without PTSD (or other prefrontal dysfunction), the frontal lobes have adequate control over the amygdala and can quickly dampen perceived threat responses activated by a benign environmental stimulus. In individuals with PTSD, however, the frontal lobes have diminished control, leaving afflicted individuals victim to their hyperresponsive amygdala (Brewin, 2001a; 2001b; Cardenas, 2011). Within the prefrontal cortex of individuals with PTSD, several studies have concluded that more localized dysfunction in the orbitofrontal cortex is largely responsible for the symptom presentation of PTSD (Dileo et al., 2007; Vasterling et al., 2000). One study has even suggested that orbitofrontal dysfunction often precedes the development of PTSD, thereby serving as a risk factor for PTSD development (Kühn, Schubert, & Gallinat, 2011).

Orbitofrontal cortex and PTSD.

The orbitofrontal cortex (OFC) is located within the prefrontal cortex and includes several subregions, all with different patterns of connections. One region connects to the amygdala and hypothalamus, while another region connects with the medial temporal cortical areas that are involved in recognition memory (Kolb & Whishaw, 2003). The OFC plays a role in various processes of reward and self-regulation (Spinella & Miley, 2004). Specifically, the OFC is involved in coding the value of rewards (De Young, 2010), and inhibiting impulsive behavior and making explicit judgments about others' trustworthiness (Kolb & Whishaw, 2003). Lesions to the OFC result in marked changes to personality and social conduct including behavioral disinhibition, jocularity, impulsivity, reduced autonomy, insensitivity to punishment, and mood lability (Malloy, Bihrle, & Duffy, 1993). Damage to the OFC also reduces decision-making ability, impairs judgment, and leads to short-sighted and irresponsible behavior, and anosmia - the inability to perceive odor (Eslinger & Damasio, 1985; Malloy et al., 1993). Further, individuals with damage to the OFC exhibit difficulties with the learning and reversal of reward associations (Berlin, Rolls, & Kischka, 2004; Rolls, Hornak, Wade, & McGrath, 1994). The research cumulatively suggests, therefore, that OFC damage results in an overall deficit in directing behavior based on reinforcement contingencies.

As is apparent from the discussion above, the OFC is responsible for a wide variety of important behaviors. As it pertains to PTSD, research suggests that the OFC plays an important role in modulating PTSD symptoms (Kühn et al., 2011; Milad et al., 2005; Milad et al., 2008). Specifically, the OFC is thought to be largely involved in the process of extinguishing a fear response (Kühn et al., 2011; Milad et al., 2005**;** Rauch et

al., 2005). Fear conditioning takes place via classical conditioning whereby a neutral stimulus (conditioned stimulus, CS) is paired with an aversive, fearful stimulus (unconditioned stimulus, UCS) (Pavlov, 1927). Thereafter, the CS becomes a feared stimulus because of its association with the UCS. Fear extinction occurs when new learning takes place that determines that the CS no longer predicts the UCS and the conditioned response (CR) is therefore inhibited.

Research suggests that the OFC is involved in fear extinction based on studies that have found a relationship between the cortical thickness of the medial OFC and retention of the extinction memory (Milad et al., 2005; Rauch et al., 2005). Therefore, when a CS elicits an initial fear response, the OFC is likely involved in dampening the amygdala's response based on new learning that the CS no longer predicts danger. This process does not appear to operate effectively in individuals with PTSD. Individuals with PTSD have been found to have deficits in fear extinction recall, or the ability to retrieve the newly learned information that determined that the feared stimulus no longer predicts danger (Milad et al., 2008). Additionally, research on patients with OFC lesions concluded that OFC damage results in failure to change behaviors in response to changing reinforcement and/or punishment rather than a failure to learn the stimulus-reinforcement relationship (Berlin et al., 2004). The result is that individuals with dysfunction in the OFC are unable to dampen the emotional response that arises when they encounter a CS. The OFC, therefore, plays a critical role in facilitating the human ability to redirect behavior based on new learning. When there is dysfunction in the OFC, as is hypothesized to exist in individuals with PTSD, symptoms of PTSD appear to be

more likely to develop and more likely to be maintained over the course of time due to a reduced ability to retain extinction memory.

Research has demonstrated that individuals with combat-related PTSD exhibit OFC dysfunction (Dileo et al., 2008; Vasterling, Brailey, & Sutker, 2000). Research exploring OFC dysfunction has found lower volume bilaterally in the lateral OFC in individuals who have been exposed to combat-related trauma but do not meet criteria for PTSD (Eckart et al., 2011). Similarly, research has observed lower OFC volume in individuals with non-combat-related PTSD (Milad et al., 2005; Rauch et al., 2003; Rauch et al., 2005). Research also suggests that when exposed to trauma-related cues, the prefrontal cortex (PFC) in individuals with PTSD fails to activate when compared to the PFC of individuals who do not have PTSD (Bremner et al., 2004; Shin et al., 2004). Additionally, other research has demonstrated that individuals with PTSD tend to be deficient in behavioral extinction overall (Orr et al., 2000). Further, evidence was found to support the idea of a "building block effect," whereby the extent of traumatization moderated the amount of volume loss in the OFC: the more trauma the participant had experienced, the more severe the volume loss in the lateral OFC (Eckart et al., 2011). Decreased volume in the medial OFC (mOFC) has also been associated with anxiety disorders in general (Bienvenu et al., 2001). Therefore, reduced volume in the OFC appears to be associated with PTSD (Dileo et al., 2008; Eckart et al., 2011).

Given the emerging evidence of the importance of the OFC in conditions like PTSD, it is important to develop non-invasive methods of measuring orbitofrontal dysfunction that can utilize larger sample sizes because relatively intrusive imaging studies are expensive and tend to rely on small sample sizes. Olfactory identification

tasks offer an alternative method of inferring OFC functioning that is becoming more frequently employed in the literature as a way to detect orbitofrontal dysfunction.

Olfactory identification tasks have been shown to be associated with OFC functioning. Research has demonstrated increased activity of the OFC during olfactory identification (OI) tasks, as well anosmia (the inability to perceive odor) in individuals with damage to the OFC (Savic, Bookheimer, Fried, & Engel, 1997; Savic & Gulyas, 2000). The right OFC is thought to be especially important in OI tasks (Kjelvik, Evensmoen, Brezova, Haberg, 2012). In addition to odor identification, the OFC plays a crucial role in judging the pleasantness of an odor (Dileo et al., 2008; Vasterling, Brailey, & Sutker, 2000). OI tasks are therefore increasingly being used to detect OFC dysfunction in individuals with PTSD (Dileo et al., 2008; Vasterling, Brailey, & Sutker, 2000).

Two research studies have used OI tasks to investigate OFC functioning in Vietnam or Vietnam-era Veterans (Dileo et al., 2008; Vasterling, Brailey, & Sutker, 2000). Both studies found participants with PTSD were significantly worse at identifying odors than controls. Additionally, no between-group differences were found on other cognitive tasks designed to assess dorsolateral prefrontal cortex, ventral prefrontal cortex, and medial temporal lobe functioning. Together, the results of these two studies provide evidence for more localized OFC dysfunction in the neurological processes underlying PTSD (Dileo et al., 2008; Vasterling et al., 2000).

Thus far, the clinical presentation and neurological correlates of PTSD have been discussed. Another area meriting further research in terms of its potential impact on the maintenance and/or development of PTSD is personality theory. Personality, the enduring

and stable aspect of ourselves, impacts the way we interact with our environment and the effect the environment has on us. It would make sense, therefore, that personality may play a larger role in determining the course of mental health disorders than has previously been thought.

Big Five Personality Traits

The Five Factor Model of personality, which is the most popular personality conceptualization, adopts trait theory, which states that individuals can be characterized in terms of relatively enduring patterns of thought, action, and behavior, and that these patterns are relatively generalizable across different situations (John, Nauman, & Soto, 2008). Traits are neither too broad in that they are unable to distinguish between one person and another, nor are they too narrow in that they are unable to produce generalizable information (John et al., 2008). The five factors are neuroticism, extraversion, conscientiousness, agreeableness, and openness to experience. Although the broadness of these traits allows for predictions and generalizations to be made, subsumed under each of the traits are several personality characteristics called facets. Facets are narrower personality characteristics that add descriptive power to the broad five factors.

Personality Traits and the Orbitofrontal Cortex Region

Several personality traits are correlated with variation in the structure and/or function of the orbitofrontal cortex (OFC). Individuals who score low on neuroticism exhibit increased activation in the OFC in response to humor (Mobbs et al., 2005). Extraversion is associated with increased OFC volume (De Young et al., 2010), and OFC activation increases in response to humor (Mobbs et al., 2005) and in response to receiving a reward (Cohen et al., 2005). Agreeableness is also associated with the OFC.

People who score low on agreeableness exhibit reduced grey matter volume in the OFC (Mahoney et al., 2011). Additionally, studies utilizing patients with lesions to the OFC found that OFC lesions were associated with impulsive aggression (Blair & Cipolotti, 2000). Similarly, other studies found that anger induction was associated with OFC activation in healthy adults (Dougherty et al., 1999; Kimbrell et al., 1999). However, one study did not find any differences in extraversion, neuroticism, agreeableness, or conscientiousness between patients with OFC lesions, patients without OFC lesions, and normal controls (Berlin, Rolls, & Kischka, 2004). Overall, therefore, it appears that "positive" personality traits, such as emotional stability and extraversion, may be associated with increased volume and increased activity in the OFC in response to rewarding stimuli, whereas "negative" personality traits, such as neuroticism and hostility, may be correlated with decreased volume in the OFC.

Additionally, research examining the relationship between olfaction and personality found that the anxiety and self-consciousness facets of neuroticism were significantly positively associated with olfactory threshold (Havliček et al., 2012). There are significant positive relationships of olfactory sensitivity with neuroticism (Pause et al., 1998) and extraversion (Koelega, 1970). Another study found a significantly positive relationship between olfactory sensitivity and agreeableness, but did not find any significant associations between neuroticism or extraversion and olfactory sensitivity (Croy et al., 2011). However, at least one study has failed to find a relationship between olfactory threshold, olfactory identification, and personality (Koelega, 1994). Another study measured olfactory sensitivity by measuring a participant's ability to correctly identify a shirt belonging to their roommate by smell alone (Zhou & Chen, 2009). They

found a relationship between emotional awareness and olfactory sensitivity as well as between emotion recognition and olfactory sensitivity (Zhou & Chen, 2009). Although this study did not directly measure personality traits, these results support a potential relationship between olfaction and emotional awareness. It therefore appears that although research has documented a fairly reliable relationship between variability in the structure and/or function of the OFC and personality, the relationship between personality traits and olfaction remains ambiguous. A clear pattern has emerged, however, linking OFC functioning to psychological disorders.

OFC dysfunction has been associated with a variety of anxiety problems including panic disorder (e.g., Asami et al., 2009; Sobanski et al., 2010), obsessive-compulsive disorder (Szesko et al., 1999), and trait anxiety (Kühn, Schubert, & Gallinat, 2011). Trait anxiety can be conceptualized as an aspect of personality that is stable and enduring and reflects an individual's propensity to experience and express anxiety-related feelings and behaviors (Kühn et al., 2011). Therefore, trait anxiety is a characteristic tendency to respond fearfully to a wide variety of stimuli (Kühn et al., 2011), which is one of the defining features of neuroticism. The extent to which trait anxiety is associated with both OFC function and neuroticism suggests the OFC plays a role in the expression of neuroticism.

The mOFC and the nucleus accumbens (NAcc) combine to influence fear acquisition (Kühn et al., 2011). Kühn et al. (2011) explored the relationship between structural variations in the mOFC and NAcc using participants with no history of medical, neurological, or psychiatric disorders, or with a first-degree family history of psychological disorders. Using imaging techniques, it was found that reduced cortical

thickness in the right mOFC correlated significantly with increased trait anxiety. Trait anxiety also correlated with bilateral NAcc volume. This association was especially strong in the left NAcc. Further, the area within the mOFC that was negatively correlated with trait anxiety had been associated with anxiety disorders such as panic disorder, OCD, and PTSD in previous studies (e.g., Asami et al., 2009). The authors noted the particular relevance of these findings given that their participants did not have a personal or first-generation family history of psychiatric disorders. Therefore, the cortical thinning found in the mOFC along with enlargement of the NAcc appear to reflect structural preconditions to the development of an anxiety disorder rather than consequences or side effects of an anxiety disorder. Additionally, this neurological vulnerability reflects both aspects of fear conditioning: enlarged NAcc increases sensitivity to form fear associations, while the reduced volume in the mOFC leads to difficulty extinguishing the fear response. This study by Kühn et al. (2011) demonstrates the importance of studying the neurological foundations of personality traits as potential risk factors for later development of mental health disorders.

Personality, PTSD, and Orbitofrontal Cortex

Personality traits, neurological processes, and PTSD symptomology appear to interact with one another in a complex manner that research has not been able to fully identify. From the research that has been conducted on each of these separate areas, a pattern does emerge such that individuals with PTSD may generally score relatively high on neuroticism and low on extraversion. They further suggest that neurological processes, especially those located within the OFC, underlie neuroticism and are associated with development of anxiety conditions such as PTSD. Research corroborates this link

between neuroticism, extraversion, and PTSD, specifically in regard to symptom presentation.

Several studies have found that personality traits moderate symptom severity in PTSD. One study found a relationship between agreeableness and the avoidant symptom cluster of PTSD, whereby higher levels of agreeableness were associated with more avoidant symptoms (Hyer et al., 1994). Another study found that neuroticism was more strongly related to the hyperarousal and avoidant symptom clusters than to the reexperiencing cluster, while introversion was correlated with avoidant symptoms (Rademaker, van Zuiden, Vermetten & Geuze, 2010). Thus, personality traits may work together to partially determine which symptoms will be most prevalent in a particular person's presentation of the disorder. For example, premorbid neuroticism may serve as a vulnerability factor in the development of PTSD. The other traits, rather than predicting PTSD development per se, may instead contribute to different symptom presentations and the general heterogeneity often observed in this population.

Research examining the relationship of neuroticism and extraversion to PTSD has largely focused on the prefrontal cortex; variation in the prefrontal cortex size and activation is associated with expressions of neuroticism, extraversion, and PTSD. As previously explained, dysfunction in the prefrontal cortex is implicated in the maintenance of PTSD (Cardenas et al., 2011). Individuals with PTSD exhibit overall thinning in the prefrontal cortex compared to control participants without PTSD (Geuze et al., 2008; Milad et al., 2005; Rauch et al., 2003; Rauch et al., 2005). This generally reduced volume in the prefrontal cortex is thought to play a role in the inadequate control exercised by the prefrontal cortex over the amygdala in response to amygdala activation

(Brewin, 2001a; 2001b; Cardenas et al. 2011). Similarly, several Big Five traits are associated with gross structural and functional variation in the prefrontal cortex. Individuals who score high on neuroticism exhibit reduced volume in the dorsomedial prefrontal cortex (De Young et al., 2010) and less activation in the right prefrontal cortex in response to humor (Mobbs et al., 2005). Extraversion, on the other hand, is associated with increased activation in the right prefrontal cortex in response to humor (Mobbs et al., 2005).

Research specifically examining the orbitofrontal cortex also leads to the conclusion that PTSD may be associated with high neuroticism and low extraversion. Individuals with PTSD exhibit reduced volume in the OFC (Dileo et al., 2008; Eckart et al., 2011). Individuals who score low on neuroticism exhibit increased activation in the OFC in response to humor (Mobbs et al., 2005). Similarly, extraversion is associated with increased volume in the OFC (De Young et al., 2010) as well as increased activation in response to humor (Mobbs et al., 2005) and in response to receiving a reward (Cohen et al., 2005). Additionally, one study found that extinction retention -- the ability to recall that a conditioned stimulus no longer predicts danger -- and increased volume in the mOFC are positively associated with extraversion (Rauch et al., 2005)**.** Further, using path analysis, this same study found that extinction retention mediated the relationship between volume in the mOFC and extraversion (Rauch et al., 2005). Therefore, increased volume or activity in the OFC is associated with emotional stability and extraversion, whereas reduced volume is associated with neuroticism and PTSD. At this point, it is impossible to definitively conclude whether these personality traits precede the

development of the disorder, arise after the experience of the trauma, or whether these personality traits moderate the severity of symptoms present in PTSD.

At least two studies have linked premorbid levels of neuroticism or trait anxiety to development of PTSD following exposure to a traumatic stressor (Kühn, Schubert, Gallinat, 2011; Parslow, Jorm & Christensen, 2006). Another study documented accelerated atrophy in several brain areas that are associated with neuroticism following the onset of PTSD (Cardenas et al., 2011). This seems to suggest that neuroticism and its associated neurological underpinnings may predispose an individual to the development of PTSD, and in turn, PTSD may, at least partially, change a person's personality to reflect higher levels of neuroticism and lower levels of extraversion. There may, therefore, be a complex interaction between one's premorbid personality traits and the neurological changes that result from PTSD. This interaction may serve to maintain the disorder or it may moderate symptom severity.

Current Study

The purpose of the current study was to explore the relationship between personality traits, OFC dysfunction, and PTSD. The hypotheses were as follows:

Hypothesis 1: Personality traits would be related to olfactory sensitivity such that

a) as neuroticism scores increase, olfactory sensitivity would decrease, and
b) as extraversion scores increase, olfactory sensitivity would increase.

Hypothesis 2: PTSD would be related to olfactory sensitivity such that as PTSD symptoms increase, olfactory sensitivity would decrease.

Hypothesis 3: Neuroticism and extraversion would moderate the relationship between PTSD and olfactory sensitivity such that individuals with high PTSD symptoms and high neuroticism would exhibit decreased olfactory sensitivity when compared with individuals with high PTSD symptoms and low neuroticism scores. No moderation is expected between low PTSD symptoms and neuroticism scores. Similarly individuals with high PTSD symptoms and high extraversion scores would exhibit greater olfactory sensitivity than individuals with high PTSD symptoms and low extraversion scores. No moderation is expected between low PTSD symptoms and extraversion scores. Additionally, a three-way interaction between extraversion, neuroticism, and PTSD symptoms was examined.

Exploratory analyses examining potential relationships between Big Five personality traits, personality facets, and PTSD symptom clusters were also conducted. These analyses represent a novel contribution to the field, as research has not yet examined how personality traits and facets impact the expression of particular PTSD symptom clusters.

Regarding the relationship between various personality traits and facets and PTSD symptoms, a relatively clear pattern emerged from the analyses. It appears that overall, personality traits and facets that are more activating, like the activity facet of extraversion and the anger facet of neuroticism, are associated with higher levels of PTSD symptoms. This could be the result of increased premorbid levels of physiological arousal that increase one's vulnerability for PTSD development. It could also be the result of a tendency to continue to engage in activities that tend to trigger PTSD symptoms, possibly while engaging in cognitive avoidance strategies. Lastly, this relationship could be

explained by a tendency to engage in distracting activities to cope with trauma to the exclusion of the emotional and cognitive processing that needs to take place in order to place the trauma safely in a historical context. On the other hand, the relationship between PTSD and these more activating personality characteristics could be explained by the PTSD symptoms themselves. Specifically, the impact of trauma on one's personality structure could be, in part, an increase in these activating personality features.

Another relationship emerged whereby the conscientiousness trait and achievement-striving facet of conscientiousness, were also positively associated with PTSD symptoms. This relationship between conscientiousness and PTSD symptoms was somewhat surprising, but could also be due to a tendency of conscientious individuals to continue engaging in needed activities (e.g., school, work) that may be triggering, while possibly utilizing cognitive and emotional avoidance strategies. The relationship between conscientiousness and numbing symptoms supports the conclusion that these individuals engage in cognitive and/or emotional strategies designed to avoid unwanted emotional stimulation, thereby mitigating the therapeutic effects of continued engagement in these activities. Another possible explanation for this relationship involves the tendency for individuals on the higher end of the conscientiousness spectrum to be "perfectionists." As such, their experience with trauma, especially if their experience included a single trauma that occurred later in life, and the emotional difficulty they experience as a result of the trauma, may increase their experience of PTSD symptoms as a function of their desire to avoid experiencing unwanted negative emotions.