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The influence of Harm Avoidance and Novelty Seeking temperament traits on emotional processing

by

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ABSTRACT

The purpose of this study is to explore the differences within specific temperament traits on emotional processing bias. Participants with extremes in temperament traits Harm Avoidance and Novelty Seeking were categorised and their performance on a computerised neuropsychological test battery was investigated. First year psychology students at a residential university in South Africa were invited to participate in the original study. Processing of the data yielded a realised sample of 431 participants who completed the Emotions battery, which comprised of four tasks. The results show that processing of affective valence varies according to individual differences within specific temperament traits. The findings suggest a negative emotion processing bias in the High HA group in comparison to the low HA group. Furthermore, the impulsive and extroverted High NS group show an increased ability to process emotional faces in comparison to the low NS group. The implications of these findings are discussed in the context of putative risk factors for psychopathological disorders.

Key terms : Temperament; facial emotional processing; personality; psychobiological theory; novelty seeking; harm avoidance; avoidance motivation; approach motivation; processing bias; sociability; psychopathology.

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CHAPTER 1

INTRODUCTION

1.1. OVERVIEW

According to Svrakic, Przybeck and Cloninger (1992) it has been hypothesised for centuries that personality is influenced by emotions. Numerous studies have been conducted to shed more light on the nature of this relationship and recent studies have focussed specifically on the association between temperament and emotional processing, with reference to neuroanatomy, psychopathology and motivation (Bermpohl et al., 2008; Brown, Svrakic, Przybeck & Cloninger, 1992; Cloninger & Svrakic, 1997; Kovalenko & Pavlenko, 2009; Lohr, Teglasi & French, 2004; Mühlberger et al., 2009; Murphy, Downham, Cowen & Harmer, 2008; Stadler et al., 2007). Research has also turned its focus towards the neurophysiological aspects underlying and contributing toward temperament (Bond, 2001; De Pascalis, 1993; Gardini, Cloninger & Venneri, 2009; Henderson & Wachs, 2007; Katsuragi et al., 1999; Stuettgen, Hennig, Reuter & Netter, 2005; Vormfelde et al., 2006), as well as emotional processing (LeDoux, 2003; Mayes, Pipingas, Silberstein & Johnston, 2009). The results of these studies have important implications for understanding the predisposing factors in psychopathology.

The focus of this study is on the relationship between temperament and emotional processing. Whilst research has established that there is a relationship between the two variables, there appears to be a lack of research focussing specifically on the influence of differences within particular temperament traits on emotional processing. Such information would prove valuable in the assessment of, and treatment planning for psychopathologies, since pharmacotherapy and psychotherapy could then be matched to individual personality structures (Cloninger & Svrakic, 1997).

The temperament traits selected for this study are harm avoidance (HA) and novelty seeking (NS), two of the four temperament dimensions assessed by Cloninger's Temperament and Character Inventory (TCI). HA has been linked to anxiety and affective disorders such as Major Depressive Disorder and Generalised Anxiety Disorder, whilst NS has been linked to personality disorders such as Antisocial Personality Disorder and Conduct Disorder (Cloninger & Svrakic, 1997).

What follows is a brief explanation of the research problem and motivation for conducting this study. The chapter will then conclude with an overview of the structure which the dissertation will follow.

1.2. RESEARCH PROBLEM

This study seeks to explore the influence of the varying intensities within the temperament traits HA and NS on emotional processing. Based on previous research there appears to be an association between temperament and emotional processing, specifically in terms of recognition and discrimination of emotional stimuli (Adams, Ambady, Macrae & Kleck, 2006; Bermpohl et al., 2008; Mayes et al., 2009; Mühlberger et al., 2009; Stadler et al., 2007; Yoshino et al., 2005). It is expected that different levels within the traits of HA and NS will influence how individuals process emotional stimuli, and hence that participants exhibiting extremes in HA and NS will perform differently on an emotion recognition and discrimination test battery. The question this study intends to answer is whether participants with differences in the levels of specific temperament traits evidence emotional processing bias. The aim is therefore to determine whether groups:

i) High and low in HA perform differently on tasks of emotional recognition and emotional discrimination;

ii) High and low in NS perform differently on tasks of emotional recognition and emotional discrimination.

1.3. MOTIVATION

Several studies have considered the relationship between temperament, emotions and psychopathology, particularly regarding anxiety and personality disorders (Bermpohl et al., 2008; Brown et al., 1992; Stadler et al., 2007; Svrakic et al., 1992; Whittle, Allen, Lubman & Yücel, 2006). There is, however, a paucity of research focussing specifically on differences within temperament traits and the resultant differences in processing of emotional stimuli. According to Murphy et al. (2008) cognitive psychological theories emphasise the role that mood congruent biases in emotional processing play in the maintenance of anxiety disorders. If it can be shown that differences within temperament traits influence emotional processing, a greater understanding of psychopathologies might be achieved, since temperament traits can then be seen as a possible predisposing factor to certain disorders. The aim of this study is therefore to establish whether groups scoring differently in both HA and NS perform differently on tasks of emotional recognition and emotional discrimination.

1.4. DISSERTATION STRUCTURE

The literature review provides an outline of research conducted in the areas of temperament and emotional processing, taking into consideration neurobiological underpinnings and motivation, with specific reference to the psychobiological model of Robert Cloninger (1987). This is followed by the methodology which describes the research design, sampling and instruments used, and procedure for data gathering. A presentation of the results follows, which includes biographical information on the sample, descriptive statistics of the data and results of the inferential analyses. The dissertation then proceeds with a discussion of the findings in which the theory, results and literature reviewed are integrated and the strengths and limitations of the study are discussed. The dissertation ends with recommendations for future research and a final conclusion.

1.5. **CONCLUSION**

Whilst a number of studies have considered the link between temperament and emotional processing, few studies have been conducted to determine whether differences within specific temperament traits influence emotional processing. This investigation will therefore contribute to the knowledge base regarding specific predisposing factors which may increase vulnerability to certain psychopathologies, thereby aiding in assessment and treatment of same.

CHAPTER 2

LITERATURE REVIEW

2.1. INTRODUCTION

The aim of this study is to explore the influence of differences within specific temperament traits on emotional processing. According to Cloninger's psychobiological model, as measured by the temperament and character inventory (TCI), personality encompasses both temperament and character (Cloninger, Svrakic & Przybeck, 1993). Character has been defined as individual differences in goals and values based on insight learning, and consist of three dimensions, namely self-directedness, cooperativeness and self-transcendence (Cloninger and Svrakic, 1997). Temperament has been defined as individual differences in associative learning in response to novelty, danger or punishment, and reward (Cloninger et al., 1993). Cloninger et al. (1993) state that temperament consists of four different dimensions, namely harm avoidance, novelty seeking, reward dependence and persistence. Harm avoidance (HA) is characterised by anxiety, which is evidenced by anticipatory worry, shyness and easy fatigability, all in response to signals of punishment or frustrative non-reward. Novelty seeking (NS) is characterised by exploration, impulsiveness and disorderliness and is seen as a tendency to respond appetitively to novel stimuli or potential rewards and actively avoid monotony and punishment. Reward dependence (RD) is described as the maintenance of behaviour in the face of rewards, especially social rewards, and is observed as sentimentality, attachment and dependence on approval. Persistence (P) is considered to be a tendency to maintain behaviour in extinction conditions and is observed as industriousness, determination and perfectionism (Ball, Tennen & Kranzler, 1999; Goncalves & Cloninger, 2010; Van Berkel, 2009; Yoshino et al., 2005). The dimensions of HA and RD have been shown to be behavioural inhibitors, whilst NS and P are responsible for behavioural activation (Mardaga & Hansenne, 2007). For the purpose of this study the traits HA and NS will be the focus of analysis.

Gardini et al. (2009) consider Cloninger's model as realistic for testing psychobiological hypotheses in regard to the brain systems which regulate basic emotions such as fear, anger, happiness or disgust. HA is believed to correlate highly with the expression of emotions such as anxiety and fear, whilst NS is believed to correlate highly with the expression of emotions such as anger (Gardini et al., 2009; Goncalves & Cloninger, 2010; Mardaga & Hansenne, 2007). In the case of HA, fear and anxiety can be linked to uncertainty and the anticipation of problems. In the case of NS, anger can be linked to impulsivity, a need for novel stimuli, and frustration when this is not attainable (Gardini et al., 2009).

2.2. CONSTRUCT OF PERSONALITY

There is a large body of research focussing on personality and its different dimensions. Whittle et al. (2006) state that there is some disagreement about the specific relationship between temperament and personality, with some authors arguing that temperament is a distinct component of personality, while others propose that temperament forms the core around which broader personality traits develop. Zentner and Bates (2008) suggest that the reason for this confusion stems from the two different ways of defining personality. According to these authors one view of personality relates to goals, coping styles, motives and identities (therefore characterising the individual as a whole), while the other view suggests that personality refers to specific personality traits.

Whittle et al. (2006) argue that there is, however, a general consensus that temperament dimensions are detected from infancy, are genetically influenced and are moderately but significantly maintained across development. According to Bates (cited in Henderson & Wachs, 2007) individual differences in infant temperament can be viewed as the early expression of personality traits. Henderson and Wachs (2007) state that most researchers interested in temperament have focussed on individual differences starting from three months of age. They argue that it is important to focus studies of temperament not only on infants of three months and older but on newborns as well, since individual differences in at least some temperament traits should be visible even then.

According to these authors a number of studies have been able to identify neonatal behavioural patterns such as negative emotionality, soothability and alertness. Verweij et al. (2010) argues that, although heritability estimates for the TCI scales range from 30-60%, it has proven difficult to identify specific genetic variants underlying individual differences on various personality scales, including the TCI. The authors state that their results, together with similar results from previous studies indicate that variants of moderate or large effect do not play a role in the variation of personality, which therefore leaves common and rare variants of small effect as responsible for such variation. However, Schmidt, Fox, Rubin, Hu and Hamer (2002), in a study on the molecular genetics of shyness and aggression in preschoolers, found significant associations of the DRD4 gene with maternal reports of aggression in children aged 4. The authors argue that animal and twin studies, and more recently molecular genetics studies, provide strong evidence for support of a genetic basis to temperament.

Zentner and Bates (2008) refer to several longitudinal studies that provide support for the supposition that temperament is reasonably maintained across development. In their first longitudinal study, Kagan and colleagues (cited in Zentner & Bates, 2008) found that children of two years who showed consistent avoidance or distress to unfamiliar situations maintained some of the tendencies at seven years of age. They also found that two year-olds who showed minimal avoidance tended to maintain such behaviour. In a subsequent large-scale longitudinal study by the authors it was found that high-reactive infants (examined at four months of age) were three times more likely to develop anxiety symptoms by age seven and, in adolescence, reported more frequent bouts of sadness and showed more physical signs of anxiety such as sweating palms, heart rate changes, muscle tension and breathing difficulties. According to Zentner and Bates (2008), research findings suggest that aspects of what they term *positive emotionality* (expressed as eagerness, interest and associated behaviours such as approach and investigation) tend to be quite stable across the early childhood period.

The majority of modern models of personality focus predominantly on personality traits or dimensions (Verweij et al., 2010). The psychobiological model of Robert Cloninger (1987) will be the focus of this study. According to Bond (2001) there exists substantial evidence to support a psychobiological model, and although some studies have revealed conflicting findings and not all studies have shown significant relationships, well controlled studies demonstrate the usefulness of a psychobiological model of personality.

2.2.1. Psychobiological Model of Personality

According to Henderson and Wachs (2007), the work of Pavlov is seminal in modern biological theories of temperament and personality. Pavlov and his students developed comprehensive models regarding the role of the central nervous system (CNS) regarding individual differences in motivation and emotion (Henderson & Wachs, 2007). Henderson and Wachs (2007, p. 403) state that “Pavlov hypothesised that the balance of excitatory and inhibitory CNS processes within an individual determined their style for adapting to environmental demands and therefore their personality”. According to Robinson (2001), EEG research confirmed Pavlov’s excitation-inhibition hypothesis, since melancholic personality types had higher natural frequencies and therefore a predominance of excitation, whilst sanguine personality types had lower natural frequencies and therefore a predominance of inhibition.

Pickering (1997) asserts that Pavlov was directly responsible for the use of the term *conceptual nervous system* (CoNS) when approaching the study of personality. Pickering (1997, p. 139) defines the CoNS as a “set of hypothetical interacting mental components which are responsible for the behaviour of the organism”. Pavlov further identified two types of reflexive responses, namely an orienting response towards the stimulus and a defensive response away from the stimulus (Elliot and Covington, 2001). This is in line with Cloninger’s description of personality as individual differences in motivated behaviour arranged along an appetitive-aversive dimension.

Several contemporary models of personality appear to have overlapping dimensions, including Eynsenck's three factor model, Clark and Watson's three factor model, Costa and McCrae's five factor model, Zuckerman's five factor model and Cloninger's seven factor model (Whittle et al., 2006; Zuckerman & Cloninger, 1996). In a study on the relationships between Cloninger, Zuckerman and Eysenck's dimensions of personality, Zuckerman and Cloninger (1996) found that Zuckerman's impulsive sensation seeking scale correlated highly with Cloninger's NS scale. HA correlated better with Zuckerman's neuroticism scale than with Eysenck's neuroticism scale. According to Evans and Rothbart (2007), Cloninger's model is one of the most extensively studied models of adult temperament. Furthermore, reliability and validity of Cloninger's Temperament and Character Inventory has been shown in several studies and across different cultures (Adan, Serra-Grabulosa, Caci & Natale, 2009; Ball et al., 1999; Goncalves & Cloninger, 2010; Miettunen, Kantojärvi, Veijola, Järvelin & Joukamaa, 2006)

In terms of Cloninger's psychobiological model, temperament can be seen as having its neurobiological basis in the monoamine neurotransmitter systems. Cloninger (1987) proposes that the neurotransmitters dopamine and serotonin play a role in the behavioural expression of NS and HA respectively.

2.2.1.1. Harm Avoidance and neurotransmitter function

Gardini et al. (2009) posit that individual differences in HA appear to be linked to variability in the serotonergic system. Several research studies have found a significant relationship between low levels of HA and low serotonin responses (Hansenne & Ansseau, 1999; Harmer, Heinzen, O'Sullivan, Ayres & Cowen, 2008), although it should be noted that there is some inconsistency in reports. Vormfelde et al. (2006) attempted to clarify these inconsistencies by studying serotonin transport gene (SERT) polymorphisms. They found that anxiety and novelty seeking related personality traits were differentially associated with different SERT haplotypes. They argue that it is important when conducting studies on the relationship of serotonin to personality traits, to differentiate the molecular function and clinical implications of the SERT promoter polymorphism. Katsuragi et al. (1999), in a study on the association between the serotonin transporter gene polymorphism and anxiety related personality traits, reported that a relationship was observed between a polymorphism in the serotonin transporter promoter region (5-HTTLPR) and HA. Bond (2001) reports that Lesch and colleagues has confirmed an association between the short allele of 5-HTTLPR and higher scores on HA. Bond (2001) furthermore reports that neuroendocrine challenges have revealed responses to 5-HT drugs to be associated with HA.

According to Deakin (1998), coping responses to aversive events may be modulated by 5HT projections. The author states that dysfunction of such coping mechanisms could cause generalised anxiety disorder, panic and depression, and proposes that dorsal raphe nucleus projections mediate anticipatory anxiety and motivate avoidance of threats. Deakin (1998, p. 57) believes the "brain aversion system" to be held in check by dorsal raphe nucleus 5HT projections which mediates behavioural inhibition during anticipatory anxiety. The author argues that serotonin has an inhibitory function in the ventral periaqueductal grey matter. Deakin (1998) furthermore found that tryptophan depletion, which causes a temporary reduction in brain serotonin function, led to greater anxiety scores in participants, and states that there appears to be a direct relationship between impaired 5-HT receptor functioning and depression.

Lochner et al. (2007), in a study on genetic and personality traits in patients with social anxiety disorder, found increased harm avoidance to be associated with social anxiety disorder and suggests that their results indicate a possible role for the 5-HT polymorphism in the development of social anxiety disorder. Both anxiety and depression have been related to levels of HA (Cloninger, Svrakic & Przybeck, 2006).

2.2.1.2. Novelty seeking and neurotransmitter function

Carver and Miller (2006) maintain that serotonin function is more reliable in terms of impulsiveness and aggression (related to NS) than anxiety proneness (related to HA). The authors state that when a relationship does emerge from studies it tends to link low serotonin to high anxiety. It is important to note, however, that these authors have also argued that high impulsivity (and therefore high NS) and high anxiety (and therefore high HA) is not mutually exclusive. Carver and Miller (2006) have further argued that lower serotonin levels relate to higher aggression only if the individual is already naturally aggressive, and stress that serotonin appears to be implicated in a behavioural dimension which ranges from inhibition at one end to impulsivity at the other end.

Bond (2001) confirms that an association between dopamine receptor and transporter polymorphisms and NS has been found.

According to Bermpohl et al. (2008) support for the association between NS and the dopaminergic system has come from studies on substance abuse and pathological gambling (both implicated in impulse control), Parkinson's disease, receptor-binding PET studies and animal and genetic studies. Stuettgen et al. (2005), in a neurotransmitter challenge using mazindol, found that high NS positively correlated with high levels of dopamine. Zuckerman and Cloninger (1996) believe that NS correlates negatively with the levels of the enzyme monoamine oxidase, therefore suggesting a biological basis for the temperament trait. They further state that the biological basis is demonstrated in the high heritability of NS.

2.2.2. Neural basis of temperament

Gardini et al. (2009) postulate that structural variance in specific regions of the brain may also play a part in temperament. PET studies have found regional cerebral blood flow (rCBF) values in different brain areas using different personality and temperament inventories. Gardini et al. (2009) state that, in PET and SPECT studies using Cloninger's psychobiological model, NS has been found to correlate positively with rCBF values in the anterior cingulate, and anterior and posterior insula. The anterior cingulate, which forms part of the limbic system, is a highly variable brain region involved in adjusting an individual's response to the environment and contains areas that modulate autonomic activity associated with emotions. It is also believed to be associated with the regulation of many aspects of affectivity and complex social behaviour (Pujol et al., 2002). The insula has been shown to be involved in emotional reactions to pain and recent studies suggest that it might also be involved in encoding of perceived emotions and response to observations of others' experience of such emotions (Mauguiere, 2010).

Gardini et al. (2009) further state that HA has been found to correlate negatively with rCBF values in the parahippocampal, pre-central, post-central, superior frontal, fusiform and inferior temporal gyri. The parahippocampal gyrus forms part of the limbic system which is involved in the expression of emotional behaviour (Zillmer & Spiers, 2001). The fusiform gyrus has been indicated in facial processing, specifically in the perception of emotions in facial stimuli (McCarthy, Puce, Gore & Allison, 1997).

Fischer, Wik and Fredrikson (1997), in a PET study on extraversion, introversion and brain function using Costa and McCrae's NEO-PI-R, found that rCBF values in the caudate nucleus and the putamen was higher in introverts than extroverts, and that activity in the putamen was left-lateralized for introverts. The authors further found that, as a function of extraversion, the rCBF did not differ in the prefrontal, orbitofrontal, temporopolar, cingulate, primary visual cortex, the thalamus or the hypothalamus, and suggest that extraversion therefore correlates to subcortical rather than cortical brain regions. Current research has also found cerebral glucose metabolism values in various areas of the brain. Gardini et al. (2009) assert that NS and HA has been found to correlate significantly with cerebral glucose metabolism values in the paralimbic and temporal areas of the brain.

Neuroimaging studies using MRI and MRS (magnetic resonance spectroscopy) have also found various associations between temperament and the brain. Pujol et al. (2002), using MRI, found that the large right anterior cingulate cortex is related to a temperamental disposition to fear and anticipatory worry (characteristics of HA) in both genders. Kim et al. (2009), using MRS, confirmed this finding in their study on the associations between the anterior cingulate cortex and HA. Beaton, Schmidt, Schulkin and Hall (2010), in a study on neural correlates of implicit processing of facial emotions in shy adults using fMRI, found that shy individuals showed greater neural activity than non-shy individuals across a range of brain regions during implicit facial emotion processing.

Yamasue et al. (2008) in their study on the neuroanatomical basis of anxiety related personality traits using MRI, found that higher scores on HA were associated with smaller regional grey matter volume in the right hippocampus. This was true for both genders. The authors also found a female-specific correlation between higher HA scores and smaller regional brain volume in the left anterior prefrontal cortex.

2.2.3. Behavioural Activation, Behavioural Inhibition and Temperament

According to Gray (1991), behavioural activation is governed by the behavioural approach system (BAS), which is responsive to signals of reward and moves an individual towards desired goals. Behavioural inhibition, in contrast, is governed by the behavioural inhibition system (BIS), which is responsive to signals of punishment and novelty and interrupts ongoing behaviour, or causes inhibition of movement towards goals. According to Carver and White (1994), Gray argues that the physiological mechanism of the BIS controls the experience of anxiety in response to anxiety related stimuli. He also argues that greater BIS sensitivity should be reflected in greater proneness to anxiety, provided the individual is exposed to the right situational cues. Carver, Sutton and Scheier (2000) state that Gray believes the neural structures of the BIS to include the septo-hippocampal system, its monoaminergic afferents and its neocortical projections to the frontal lobe.

Carver and White (1994) point out that the neural basis of the BAS is less clearly specified than the BIS, but that the dopaminergic pathways are believed to play an essential role. They state that greater BAS sensitivity is reflected in greater appetitive behaviour. Pickering (1997) argues that the BAS is activated by conditioned stimuli that predict reward or relief from punishment, and impulsivity is a reflection of the sensitivity of the BAS to these stimuli. This is in agreement with Cloninger's classification of NS as being characterised by high impulsivity and a tendency to respond appetitively to stimuli (Cloninger, 1987).

Mardaga and Hansenne (2007) state that HA and NS are defined as being responsible for inhibition and activation of behaviours respectively, and therefore refer specifically to BIS and BAS in their theoretical foundations. This is confirmed by Amodio, Master, Yee and Taylor (2008), who indicate that high BIS activation is related to enhanced attention, arousal, vigilance, and anxiety, as well as corresponding to anxiety related disorders, therefore referring specifically to characteristics of HA, whilst BAS has been associated with feelings of joy, optimism and aggression, thus referring specifically to characteristics of NS. This link is further confirmed by Amodio et al. (2008), who state that BAS is organised primarily by the dopaminergic neurotransmitter system, which is implicated by Cloninger (1987) to be associated with NS. Similarly, Amodio et al. (2008) argue that Gray believes the BIS to be organised by monoamine neurotransmitter systems, including the serotonergic system, which is implicated by Cloninger (1987) to be associated with HA.

Elliot and Covington (2001) argue that approach and avoidance motivation differ as a function of valence. The authors state that negative or positive evaluations of stimuli are inherently linked to a tendency to move away from or toward specific stimuli. The authors add that such automatic action dispositions are predispositions and not necessarily overt behavioural responses, which supports Cloninger's contention that unconscious procedural memories that influence personality involve pre-semantic perceptual processing. This implies therefore that behavioural tendencies in response to stimuli are not conscious decisions but influenced unconsciously by temperament.

2.3. EMOTIONAL PROCESSING

Emotion is defined by Lang, Bradley and Cuthbert (1990) as action dispositions founded on brain states that organise behaviour along a basic appetitive-aversive dimension. In terms of this definition behavioural inhibition and behavioural activation form part of the emotional processing systems that influence temperament. Consequently, on a theoretical level, the temperament dimensions as proposed by Cloninger (1987) appear to be linked to emotional processing.

According to research in this area emotional processing can be divided into a number of different aspects. Cannon (1929) proposes a hypothalamic theory of emotion which consists of three major aspects, namely: (1) the evaluation of emotion; (2) the expression of emotion; and (3) the experience of emotion. Demaree, Everhart, Youngstrom and Harrison (2005) similarly divide emotional processing into three basic categories, namely: (1) emotional perception (visual and auditory); (2) emotional expression (facial and prosodic); and (3) emotional experience.

According to LeDoux (2003), early proposals were made that the hypothalamus was the key region involved in emotional processing. Researchers believed that the hypothalamus sent signals to the brainstem where emotions were expressed as bodily responses, and to the cortex where emotions could be experienced as subjective states. Further extensive research has, however, firmly established the amygdala as the key subcortical area involved in emotional processing, especially with regard to fear. Habel et al. (2007) state that there is growing evidence supporting the amygdala as essential for several domains of emotional behaviour, including fear, emotional memory, mood induction and emotion discrimination. Dannlowski et al. (2007) believe the amygdala to be involved specifically in the identification and processing of negative stimuli, thus directing attentional resources to possible sources of threat. Since individuals high in HA are understood to have higher levels of anxiety and fear, it is reasonable to consider whether the amygdala plays a central role in specific temperament traits, and particularly in HA. Whittle et al. (2006) support this proposal by stating that individual differences in personality traits may be important in modulating amygdala responses to affective stimuli.

Posamentier and Abdi (2003) believe results of facial expression processing research suggest that different emotions are processed by different regions of the brain. According to these authors the presentation of fearful faces have shown activation in the left amygdala, left peri-amygdaloid cortex, left cerebellum, the right superior frontal gyrus and the left cingulate gyrus. Presentation of happy faces elicits activation in the right medial temporal gyrus, right putamen, left superior parietal lobule and left calcarine sulcus. Presentation of sad faces has shown activation in the left amygdala and the right middle and inferior temporal gyri. Presentation of angry faces has shown activation of the right orbitofrontal cortex and bilateral activation of the anterior cingulate cortex. Other areas implicated in emotional expression processing include the prefrontal and inferior frontal cortices (Posamentier & Abdi, 2003).

According to Phelps and LeDoux (2005), emotion systems in the brain are commonly understood as belonging to a category of systems that form implicit memories. Emotional memories are therefore formed and accessed unconsciously. This is in line with Cloninger's assertion that affective valence is pre-semantically processed and implicitly encoded (cited in Yamasue et al., 2008). Morris and colleagues (cited in Phelps & LeDoux, 2005) confirmed this assertion by finding that subliminally presented emotional stimuli caused co-activation of the amygdala and both the superior colliculus and pulvinar. These areas have been shown to be associated with rapid processing of low frequency emotional expressions (Vuilleumier, Armony, Driver & Dolan, 2003).

2.3.1. Behavioural Activation / Behavioural Inhibition Model of Emotional Processing

According to the Behavioural Activation and Behavioural Inhibition Model of Emotional Processing, the left and right frontal brain regions reflect the strength of BAS and BIS systems respectively (Demaree et al., 2005). According to these authors, anger – as a propensity towards approach emotion – is associated with high BAS activation, while fear – as a propensity towards withdrawal emotion – is associated with high BIS activation. Davidson, Saron, Senulis, Ekman and Friesen (1990) provide support for the approach-withdrawal model of brain lateralisation for emotion. The authors found that emotions linked to withdrawal, such as fear and disgust, produced more right-sided activation, while emotions linked to approach, such as happiness and certain forms of anger, produced more left-sided activation. This is confirmed by Henderson and Wachs (2007, p. 408), who state that “the left frontal region is hypothesised to be related to BAS reactions while the right frontal region is hypothesised to be related to BIS reactions”. Asymmetry as an index of temperament traits according to the BAS/BIS model is determined by comparing the relative difference in EEG activation of left from right anterior regions of the scalp (Henderson & Wachs, 2007). It should be noted that, even though there is general agreement that the right hemisphere is more specialised for emotion recognition there is, however, some disagreement in regard to hemispheric specialisation for positive and negative emotions (Gale, Edwards, Morris, Moore & Forrester, 2001).

Stemmler, Aue and Wacker (2007), in their study on the separable effects of emotion and motivational direction on somatovisceral responses, found that anger and fear (together with their motivational directions of approach and withdrawal respectively) could be separated in somatovisceral responses. These somatovisceral responses relate to the physiological responses of the somatic and autonomic systems to stimuli. Stemmler et al. (2007) state that emotion and motivational direction contributed independently, and along orthogonal dimensions, to somatovisceral responses, suggesting that anger and fear have separate underlying neurobiological organisations.

Knyazev, Bocharov, Slobodskaya and Ryabichenko (2008), in a study on personality linked biases in perception of emotional facial expressions, found that behavioural inhibition and trait anxiety predisposed individuals to the perception of all faces as more hostile. The authors argue that anxiety is a personality manifestation of BIS activity, and is associated with sensitivity to negative emotional stimuli. Gray (cited in Carver & White, 1994) concurs, characterising the nature of personality developing from BIS sensitivity as anxiety proneness. Knyazev et al. (2008) further found that the extraversion dimension of BAS predisposed individuals to be more sensitive to positive facial expressions, whilst BAS trait anger predisposed individuals to the perception of faces as more hostile. Interestingly, the effect for trait anger was only found during the perception of female faces.

Adams et al. (2006), in a study on whether emotional expressions forecast approach-avoidance behaviour, found that approach movement was detected faster by participants when the expression was anger. They state that the expression of anger communicates an approach motivation by the expressor, but tends to elicit avoidance behaviour in an observer, whilst the expression of fear communicates an avoidance motivation, but tends to elicit approach behaviour in an observer. Harmon-Jones (2003), in a study on anger and the behavioural approach system, found that trait anger correlated positively to BAS. Similarly, Carver and Harmon-Jones (2009) state that a great deal of evidence links anger to an approach motivational system. They further state that the various definitions of anger as affect imply that the emotion results from disrupted approach, thereby further substantiating the connection between NS and anger as approach motivation.

2.3.2 Temperament and Emotional Processing

Brown et al. (1992) believe that the concepts of personality, motivated behaviour and emotionality overlap and state that "personality is observed as individual differences in motivated behaviour and emotionality" (p. 197). Cloninger and Svrakic (1997) consider temperament to refer to our individual emotional predispositions. According to these authors each temperament trait is independently heritable, with the result that different configurations within individuals predispose them to distinct patterns of emotional responses due to functional interaction amongst the different temperament traits. Cloninger and Svrakic (1997) further state that each dimension of personality is associated with different emotional states, depending on the stimulus conditions. Clinicians can therefore predict emotional responses to specific situations, or infer personality structures from patterns of emotional reactivity.

Svrakic et al., (1992) believe HA to be useful in studies of the relationship between temperament, emotion and psychopathology, since changes in HA reflect changes in mood states, which point to specific areas and processes in the brain that are responsible for determining motivational aspects of observable behaviour. Lohr et al. (2004) argue that temperament indirectly influences individual experience and psychopathology. They state that the influence occurs through the selection of environments and activities in an attempt to regulate temperamental reactivity. This can be seen, for example, in the fearful avoidance of novel stimuli in individuals high in HA which, together with additional factors, could predispose an individual to Generalised Anxiety Disorder. This view is confirmed by Foa and Kozak (1986) who propose that pathological fear structures underlie the anxiety disorders. Furthermore, negative processing biases and anxiety, characteristic of HA, have been implicated in the development and maintenance of depression (Sue, Sue & Sue, 2003). Strelau and Zawadzki (2011), in a study on temperament traits related to anxiety disorders, found that emotional reactivity predicted acute anxiety, phobias, obsessive-compulsive disorder and generalised anxiety disorder.

Stadler et al. (2007), in an imaging study using fMRI, found that the anterior cingulate cortex (ACC) showed reduced activation in adolescents with conduct disorder (CD) when viewing affective pictures. The ACC plays an essential role in the regulation of cognitive and emotional behaviour and the researches propose that their results indicate impaired cognitive control of emotional behaviour in patients with CD. According to these authors, the ability to control behaviour and emotion cognitively is determined by various temperament factors. They state that a number of studies have shown that the risk for the development of aggressive behaviour problems is increased in individuals with high NS. In considering the relationship between temperament and neuropsychological functioning, they further state that their results indicate that suppressed ACC activation is associated with NS.

2.3.3. Recognition and discrimination of emotionally valenced stimuli

Adams et al. (2006) and Mayes et al. (2009) argue that the recognition and discrimination of emotion is critical for social interaction. Kamio, Wolf and Fein (2006), who found that social deficits in individuals with autism may result partly from a failure in the ability to evaluate the emotional significance of emotional faces, affirm this view. Phelps and LeDoux (2005) similarly state that individuals with damage to the amygdala show deficits in social responses, especially when interpreting facial expressions such as fear.

According to Cloninger and Svrakic (1997, p. 121), "temperament refers to differences between individuals in their automatic responses to emotional stimuli". They state that temperament traits include basic emotional response patterns such as fear versus calm, thrill versus anger, disgust versus attachment and tenacity versus discouragement. In the face of novel or emotional stimuli, individuals high in HA would therefore respond with anxiety and fear, whilst individuals low in HA would respond calmly and with courage. Individuals high in NS would respond appetitively to positive stimuli, actively avoid negative stimuli and would express anger when frustrated in their attempts either to approach or avoid such stimuli. In line with this, De Pascalis, Strippoli, Riccardi and Vergari (2004) found that, when processing emotional words, anxious individuals were more sensitive to negative emotions than non-anxious individuals. Similarly, Pickett and Kurby (2009), in a study of experiential avoidance, found that individuals scoring higher on experiential avoidance showed a bias toward activating negative emotion inferences.

Previous research indicates a theoretical and conceptual association between temperament and emotional processing, specifically in terms of recognition and discrimination of emotional stimuli. Several studies have concentrated on recognition and discrimination of facial emotions by valence or specific emotion, using both clinical and non-clinical samples. One such study was conducted by Yoshino et al. (2005) regarding the relationship between temperament dimensions and unconscious emotional responses, using emotional faces as visual stimuli. Yoshino et al. (2005) found that responses varied in accordance with temperament traits. The authors state that "autonomic response patterns to unconscious emotional perception differed within NS and HA dimensions, suggesting that the manner of unconscious emotional responses differed according to the dimension of temperament" (Yoshino et al., 2005, pp. 3-4). They found that the high NS group scored higher on both negative and positive stimuli than neutral stimuli, whilst the low NS group scored similarly for all stimulus conditions. The high HA group scored higher on all stimulus conditions than the low HA group. In a similar study focussing specifically on socially anxious individuals, Mühlberger et al. (2009) found that highly anxious individuals scored higher than less anxious individuals for all stimulus conditions. They state that their results indicate that social anxiety influences early perceptual processing of faces. Based on these results it could therefore be argued that extremes within HA and NS may influence emotional processing.

It is therefore suggested that individuals high in NS (characterised by anger, exploratory activity and approach behaviour) will score differently to individuals low in NS (characterised by stoicism, reflection and tolerance) when processing emotional stimuli. It is expected that individuals high in NS will respond significantly to high-arousal stimuli (both positive and negative), but not to neutral stimuli, since NS is characterised by thrill-seeking. It is expected that individuals high in NS will score lower in a facial memory task since high NS is characterised by impulsiveness and easy boredom. It is also expected that the high NS group will respond faster on all stimuli conditions, since individuals high in NS are seen to respond appetitively to novel stimuli or potential rewards. It is suggested that individuals high in HA (characterised by fear and withdrawal or inhibition behaviour) will score differently to individuals low in HA (characterised by courage and optimism). Since high HA is considered to reflect increased “autonomic arousal and attention to apprehension arising in relation to daily events” (Yoshino et al., 2005, p. 5) it is expected that individuals high in HA will respond significantly to all stimuli (positive, negative and neutral). Since HA is characterised by Miettunen et al. (2006) as a tendency to respond intensely to signals of aversive stimuli, it is also expected that individuals high in HA will show quicker response times than individuals low in HA in recognising and discriminating between negative emotions (sad, fearful or angry faces).

2.4. CONCLUSION

In this chapter the construct of personality was considered with specific reference to temperament, as proposed in the psychobiological model of Robert Cloninger. The link between temperament and emotional processing was considered within the framework of the behavioural activation and inhibition systems, and the recognition and discrimination of emotionally valenced stimuli were explored.

In summary, temperament refers to individual differences in behaviour having specific neurobiological underpinnings. The neurotransmitters serotonin and dopamine assume key roles in moderating levels of HA and NS. HA and NS are, in turn, related to the brain systems which govern behavioural inhibition (BIS) and activation (BAS), respectively. The concept of temperament can be extended to include an individuals' automatic responses to emotional stimuli and research has indicated that the temperament traits HA and NS are associated with emotional processing.

CHAPTER 3

RESEARCH METHODOLOGY

3.1. INTRODUCTION

This study forms part of a larger grant-funded research initiative. The original study comprised data collected over a period of two years. The administration of the computerised neuropsychological test battery was approved and implemented in collaboration with the University of Pennsylvania, Brain Behavior Center. The choice of a computerised battery facilitated group administration of tests, and has been shown to be feasible for testing of non-clinical samples (Gur et al., 2001). With the technical support of researchers at the Brain-Behavior Laboratory at the University of Pennsylvania, a web-interface was set up between the South African site and the USA site. The complete University of Pennsylvania Computerised Neuropsychological Test Battery (PennCNP) comprises four computerised neuropsychological test batteries (Emotions, Memory, Executive Function and Abstract Reasoning, and a full battery comprising all the tests from the four batteries).

3.2 RESEARCH DESIGN

For the purpose of this study a non-experimental factorial design was employed. Data from the Emotions battery was analysed in order to establish whether differences within HA and NS influence emotional processing. The data set utilised for this study comprised raw scores on the relevant measuring instruments and no personal identifiers were included in the data files.

3.3 SAMPLE

The sample was one of convenience and first year psychology students registered for the modules Biological and Cognitive Psychology at a residential university in South Africa were invited to participate in the study. Of the 1124 registered students, 630 agreed to participate in the study. Participants with incomplete neuropsychological test and TCI data, and those with past medical and psychiatric history were omitted from the final data analyses. For the purpose of this study, processing of the data yielded realised samples of 431 (70 males, 361 females) for the NS trait (M age = 19.76, SD = 2.97) and 427 (69 males, 358 females) for the HA trait (M age = 19.72, SD = 2.94). The mean education of the sample in years was 13.23 (SD = 0.58). In terms of parental education, the mean education of mothers in years was 14.22 (SD = 2.78) and the mean education of fathers in years was 14.97 (SD = 3.09).

3.4 MEASURING INSTRUMENTS

A socio-demographic questionnaire was designed to capture basic data about respondents' gender, age, handedness, language of schooling, home language, parental education levels, and past and current medical and psychiatric history. Participants also completed the PennCNP Emotions Test Battery and the TCI.

3.4.1. PennCNP Emotions Test Battery

The PennCNP begins with a general sensory-motor and familiarisation trial (MPRAXIS) which allows participants to become comfortable with the computer-based testing procedure. The Emotions battery consists of the following tests: the Penn Facial Memory Test (CPF), the Penn Emotion Discrimination Task (EDF40), the Penn Emotion Recognition Task (ER40) and the Penn Emotional Acuity Test 40 (PEAT40). The tests from the Emotions battery were administered in a set order (CPF, EDF40, ER40 and PEAT40). Below is a description of each task and the performance indicators selected for statistical analyses (http://penncnp.med.upenn.edu).

i. Penn Facial Memory Test (CPF): The CPF assesses facial memory. In the first part of the test participants are shown 20 faces that they will be asked to identify later during immediate and delayed recall trials (delayed recall = CPFdelay). During the immediate recall trial (CPF), participants are shown a series of 40 faces. The series includes the 20 faces that participants were asked to memorise mixed with 20 novel faces. All facial stimuli are black and white photographs of faces rated as having neutral expressions, balanced for gender and age (Gur et al., 2001).

Faces are pasted on a black background into which hair blends, thereby removing the hair's identifying characteristics. The participants' task is to decide whether or not they have seen the face before by clicking with the mouse on one of four buttons, presented in a 4-point scale: "definitely yes", "probably yes", "probably no" and "definitely no". Performance measures selected for analysis on the CPF were true positives (correct responses) and true positive median response times (RT), measured in milliseconds (ms).

ii. Penn Emotion Discrimination Task (EDF40): The EDF40 is a measure of emotion discrimination. Participants are shown 40 pairs of faces, one pair at a time. Each pair of faces consists of two pictures of the same person. The two faces display either the same intensity of expression or a subtle, computer-generated difference in the intensity of the emotion. All facial stimuli are black and white photographs of Caucasian actors and actresses analysed and reviewed as described in Erwin et al. (1992). For each pair, the participant must decide which face expresses the given emotion more intensely or whether they are equally emotional. There are a total of 40 questions: 18 questions where one of the faces is happier; 18 where one of the faces is sadder than the other and four questions where the faces are equally happy or equally sad. Performance measures selected for analysis on the EDF40 are as follows:

- Correct responses for Happy Trials
- Correct responses for Sad Trials
- Median RT for correct Happy Trials, measured in ms
- Median RT for correct Sad Trials, measured in ms

iii. <u>Penn Emotion Recognition Task (ER40)</u>: The ER40 is a measure of emotion recognition. Participants are shown a series of 40 faces one at a time, and asked to determine what emotion the face is showing for each trial. There are five answer choices: happy, sad, anger, fear and no emotion. Participants respond to each trial by clicking with the mouse on the word describing the emotion they ascribe to the face. There are four female faces for each emotion (4 x 5 = 20) and four male faces for each emotion (4 x 5 = 20). The faces are coloured pictures taken, analysed and rated as described in Gur et al. (2002) and Kohler, Turner, Gur and Gur (2004). These faces were derived from the University of Pennsylvania Emotion Recognition Task, 96 faces version, balanced for equality and intensity of emotion, age, gender and ethnicity (Kohler et al., 2004).

Performance measures selected for analysis on the ER40 are as follows:

- Correct responses
- Median RT for Correct responses, measured in ms
- Correct Anger Identifications
- Correct Fear Identifications
- Correct Happy Identifications
- Correct Neutral Identifications
- Correct Sad Identifications
- Median RT for correct Anger Identifications, measured in ms
- Median RT for correct Fear Identifications, measured in ms
- Median RT for correct Happy Identifications, measured in ms
- Median RT for correct Neutral Identifications, measured in ms
- Median RT for correct Sad Identifications, measured in ms
- Correct Mild Identifications
- Correct Extreme Identifications
- Median RT for correct Mild Identifications, measured in ms
- Median RT for correct Extreme Identifications, measured in ms

iv. Penn Emotional Acuity Test 40 (PEAT40): The PEAT40 is a measure of emotion recognition and discrimination. The task presents 40 faces one at a time composed of five happy, five sad, and 10 neutral male and female faces (Sachs, Steger-Wuchse, Kyrspin-Exner, Gur & Katschnig, 2004). The presentation takes place in two blocks, the first of which contains sad and neutral faces (sad-neutral block); the second, happy and neutral faces (happy-neutral block). The faces are presented randomly within the blocks. Participants are asked to rate the emotional valence of the expression on each face on a seven-point scale: very sad, moderately sad, somewhat sad, neutral, somewhat happy, moderately happy, and very happy (Sachs et al., 2004). Choices are entered by clicking with the mouse on one of the seven emotion descriptions. Face stimuli were acquired as described in Erwin et al. (1992). Performance measures selected for analysis on the PEAT40 is as follows:

- Total Correct responses
- Median RT for Correct responses, measured in ms
- Very Happy Correct responses
- Median RT for correct Very Happy trials, measured in ms
- Happy Neutral Correct responses
- Median RT for Correct Happy Neutral trials, measured in ms
- Neutral Correct responses

- Median RT for correct Neutral trials, measured in ms
- Sad Neutral Correct responses
- Median RT for correct Sad Neutral trials, measured in ms
- Very Sad Correct responses
- Median RT for correct Very Sad trials, measured in ms

3.4.2. The Temperament and Character Inventory (TCI)

The TCI is a 238 item forced-choice true/false standardised self-administered questionnaire measuring four independent, largely genetically determined dimensions of temperament, as well as three character dimensions, which are supposed to be predominantly determined by socialisation processes during the life-span. The TCI instructs participants to read over each statement and circle the choice which best describes them. The TCI was chosen as a personality measure since its focus is on personality traits and can therefore be used effectively in non-clinical samples.

Internal consistency coefficients on the TCI range from 0.70 to 0.89 for the seven factors in a non-clinical sample (Cloninger, Svrakic, Przybeck & Wetzel, 1994). The TCI has been used before in different groups in South Africa (du Preez, Cassimjee, Ghazinour, Lauritz, & Richter, 2009; Peirson & Heuchert, 2001; Lochner, Simeon, Niehaus & Stein, 2002), and has shown good reliability in a university sample, with Cronbach's alphas of 0.60 to 0.85 for the temperament dimensions (Van Berkel, 2009).

The data used for this study was taken from the two temperament scales of Novelty Seeking (NS) and Harm Avoidance (HA). HA and NS scores were categorised as follows:

i) High HA: Total HA score > mean HA score

ii) Low HA: Total HA score < mean HA score

iii) High NS: Total NS score > mean NS score

iv) Low NS: Total NS score < mean NS score

3.5 PROCEDURE

Ethical clearance for the original study was obtained from the relevant departmental and faculty committees at the applicable university. Participants were required to attend one of the scheduled sessions and were assigned to groups. In total, 30 group sessions were scheduled for phase 1 of the study. Each group comprised a maximum of 25 participants. Pre-administration requirements were implemented and checked by the test administrators. Participants were seated at computer consoles in the Computer-Based Testing Laboratory (CBT) at the university. An introductory session was delivered to the participants informing them of the nature of the testing process, as well as providing information on the nature and complexity of some of the tasks. In addition to three attending researchers, eight research assistants were trained in the administration of the battery. Each research assistant was responsible for the monitoring of four participants. Upon completion of each task the research assistants had to submit the test status code (C-complete, I-incomplete) and the number 1 (good data), 2 (questionable data) or 3 (bad data) electronically for each participant.

3.6 DATA ANALYSIS

Descriptive statistics were used to indicate the sample performance on the TCI and the PennCNP Emotions battery. Distribution of the data was evaluated by means of the Kolmogorov-Smirnov test, skewness and kurtosis. The Kolmogorov-Smirnov test establishes how well "the distribution of sample data fits a theoretically specified distribution" (Hardy, 2005, p. 34). The measures revealed that the data was not normally distributed. For the purpose of this study transformations were not attempted to normalise the data since non-parametric Mann-Whitney U tests were applied to determine any significant differences within the two *a priori* defined groups (see typology above). Furthermore, multivariate analysis of variance (MANOVA) was conducted to protect against type I errors.

3.7 CONCLUSION

Chapter 3 introduced the sample characteristics and methodology, providing a detailed description of the measuring instruments and procedure followed for data gathering and analyses. This study is based on a non-experimental factorial design. Data was collected from 431 university students with a mean age of 19.76 (SD = 2.97) for the NS trait and 19.72 (SD = 2.94) for the HA trait. Students signed informed consent before completing the PennCNP and TCI, and the data was analysed using the Mann-Whitney U test and MANOVA. The following chapter will highlight the results of the analyses.

CHAPTER 4

RESULTS

The results of the study are presented in this chapter. Biographical information on the sample is included as it needs to be considered in the analysis and interpretation of the data. Both descriptive and inferential data are presented in this chapter.

4.1. BIOGRAPHICAL INFORMATION

As described in Chapter 3, the sample consisted of 431 participants. The participants' demographics were recorded including gender, age, handedness, education and parental education as described in more detail below.

4.1.1. Gender

The gender distribution of the sample was biased towards females, which formed 84% of the total sample. The males formed only 16% of the total sample.

4.1.2. Age

The participants' ages ranged from 17 to 49 years, with the majority of the sample (81%) falling between 18 and 20 years of age. A smaller number of participants (14%) fell within the 21 to 22 year age group, with fewer respondents (5%) falling within the 23 to 49 year age group.

4.1.3. Handedness

Participants were predominantly right-handed (93%). Few (5%) of participants were left-handed and 2% were ambidextrous.

4.1.4. Education

All participants had at least a Grade 12 qualification, as this is a requirement for admission to the university. The majority of the sample (82%) had attained 13 years of education, which is consistent with the population from which the sample was taken, i.e. first year university students. Seventeen percent of the sample had attained 14 to 16 years of education.

4.1.5. Parental education

Six percent of the participants' mothers had attained 11 years of education, 3% had attained 12 years of education (equivalent to a Grade 12 qualification), 16% had attained between 13 and 15 years of education and 45% had attained between 16 and 21 years of education. Five percent of the participants' fathers had attained a maximum number of 11 years of education, 30% had attained 12 years of education (again equivalent to a grade 12 qualification), 14% had attained between 13 and 15 years of education and 51% had between 16 and 21 years of education.

4.2. DESCRIPTIVE STATISTICS

4.2.1 TCI Descriptors

The sample size, mean and standard deviations for HA and NS are set out in Table 1. In comparison to Cloninger's typology (Cloninger, Przybeck, Svrakic, & Wetzel, 1994) this sample can be characterised as high in Harm Avoidance and moderate in Novelty Seeking.

Table 1

Descriptive Statistics for TCI Harm Avoidance and Novelty Seeking

Temperament Dimension	N	Mean	SD
Harm Avoidance	427	15.63	6.94
Novelty Seeking	431	20.23	6.09

4.2.2 Emotions battery descriptors

Item analysis was done to provide the descriptive statistics of the Emotions battery. The means, standard deviations, minimum, maximum, skewness and kurtosis of the Emotions battery are reported in Table 2 to 5 below. Median response times in milliseconds are indicated as "RT" and correct responses are indicated as "accuracy".

Table 2

Descriptive Statistics for Facial Memory Test

Facial Memory Test	Mean	SD	Minimum	Maximum	Skewness	Kurtosis
Accuracy	16.66	2.46	7.00	20.00	-0.88	0.82
RT	1510.46	400.64	711.00	3765.00	1.81	5.27

Table 3

Descriptive Statistics for Emotion Discrimination Task

Emotion Discrimination Task	Mean	SD	Minimum	Maximum	Skewness	Kurtosis
Accuracy for happy trials	11.65	3.36	2.00	18.00	-0.44	-0.25
Accuracy for sad trials	13.62	2.44	3.00	19.00	-0.51	1.04
RT for correct happy trials	4727.57	2049.10	1570.50	17109.00	1.79	5.86
RT for correct said trials	4015.38	1749.71	1281.00	12734.00	1.56	3.52

Table 4

Descriptive Statistics for Emotion Recognition Task

Emotion Recognition Task	**Mean**	**SD**	**Minimum**	**Maximum**	**Skewness**	**Kurtosis**
Accuracy	33.97	3.02	16.00	40.00	-1.63	6.12
RT for accuracy	1892.98	393.46	1203.00	4226.50	1.74	4.97
Accuracy for anger identifications	5.39	1.41	0.00	8.00	-0.66	1.06
Accuracy for fear identifications	7.00	1.19	1.00	8.00	-1.51	2.95
Accuracy for happy identifications	7.93	0.27	6.00	8.00	-3.64	12.87
Accuracy for neutral identifications	6.76	1.49	0.00	8.00	-1.41	1.85
Accuracy for sad identifications	6.90	1.18	1.00	8.00	-1.78	4.98
RT for correct anger identifications	2305.10	900.75	0.00	8062.00	2.11	7.67
RT for correct fear identifications	2382.14	1009.56	765.50	8695.50	2.70	10.97
RT for correct happy identifications	1539.36	272.60	742.00	3360.00	1.92	9.09
RT for correct neutral identifications	2229.10	1073.30	961.00	13734.50	4.67	37.24
RT for correct sad identifications	2019.01	674.32	1063.00	7922.00	2.94	16.47
Accuracy for mild identifications	12.62	1.74	4.00	16.00	-0.85	1.48
Accuracy for extreme identifications	14.59	1.43	5.00	16.00	-2.32	9.78
RT for correct mild identifications	2015.98	473.66	1250.00	4601.50	1.51	3.59
RT for correct extreme identifications	1785.05	413.86	1094.00	4515.00	2.10	7.57

Table 5

Descriptive Statistics for Emotional Acuity Test

Emotional Acuity Test	Mean	SD	Minimum	Maximum	Skewness	Kurtosis
Accuracy	27.94	4.73	6.00	40.00	-0.84	1.14
RT for accuracy	1895.36	480.07	937.00	3765.50	1.25	1.65
Very happy accuracy	4.35	1.23	0.00	6.00	-0.53	-0.09
RT for correct very happy trials	1796.32	525.44	765.00	4351.50	1.36	2.79
Happy neutral accuracy	10.09	2.75	0.00	14.00	-0.63	0.05
RT for correct happy neutral trials	1841.54	699.68	773.50	8250.00	3.08	18.42
Neutral accuracy	15.04	3.55	1.00	20.00	-0.90	0.81
RT for correct neutral trials	1875.84	679.14	735.00	5922.00	2.13	7.02
Sad neutral accuracy	9.95	2.29	1.00	14.00	-0.85	0.74
RT for correct sad neutral trials	2022.06	753.61	976.00	6640.00	2.02	6.40
Very sad accuracy	3.55	1.26	0.00	6.00	-0.31	-0.13
RT for correct very said trials	2174.17	725.90	0.00	5460.50	1.36	2.98

Tables 6 to 9 hereunder provide a summary of the descriptive statistics of scores obtained by each of the two *a-priori* defined groups on the PennCNP Emotions battery. Differences between each of the two *a-priori* groups will be discussed after Table 9.

Table 6

Descriptive Statistics for the High HA Group

Facial Memory Test	Mean	Median	Minimum	Maximum	SD
Accuracy	16.84	17.00	10.00	20.00	2.28
RT	1525.91	1453.00	874.50	3461.00	406.09
Emotion Discrimination Task					
Accuracy for happy trials	11.69	12.00	2.00	18.00	3.40
Accuracy for sad trials	13.64	14.00	4.00	19.00	2.35
RT for correct happy trials	4531.59	4219.00	1570.50	9938.00	1751.10
RT for correct said trials	3957.54	3539.00	1375.00	11766.00	1707.25
Emotion Recognition Task					
Accuracy	34.16	35.00	18.00	39.00	2.72
RT for accuracy	1873.21	1804.50	1359.00	3570.00	357.12
Accuracy for anger identifications	5.48	6.00	0.00	8.00	1.29
Accuracy for fear identifications	7.13	7.00	2.00	8.00	1.07
Accuracy for happy identifications	7.91	8.00	6.00	8.00	0.30
Accuracy for neutral identifications	6.70	7.00	0.00	8.00	1.60
Accuracy for sad identifications	6.93	7.00	2.00	8.00	1.11
RT for correct anger identifications	2264.20	2047.00	0.00	7734.00	910.84
RT for correct fear identifications	2339.24	2110.00	1172.00	8656.00	899.24
RT for correct happy identifications	1534.71	1500.00	1000.00	3360.00	247.00
RT for correct neutral identifications	2214.09	1890.50	1117.00	9773.00	1022.78
RT for correct sad identifications	1983.63	1867.00	1188.00	4593.50	552.68
Accuracy for mild identifications	12.76	13.00	7.00	16.00	1.57
Accuracy for extreme identifications	14.70	15.00	6.00	16.00	1.34
RT for correct mild identifications	2013.68	1930.00	1313.00	4211.00	460.53
RT for correct extreme identifications	1775.77	1687.00	1180.00	3367.00	378.56
Emotional Acuity Test					
Accuracy	27.84	29.00	12.00	38.00	4.67
RT for accuracy	1858.84	1742.00	937.00	3640.50	461.88
Very happy accuracy	4.39	4.00	0.00	6.00	1.22
RT for correct very happy trials	1780.04	1687.50	765.00	4351.50	517.93
Happy neutral accuracy	9.94	10.00	1.00	14.00	2.712
RT for correct happy neutral trials	1871.55	1667.75	773.50	8250.00	779.67
Neutral accuracy	14.97	15.50	2.00	20.00	3.54
RT for correct neutral trials	1904.48	1691.50	735.00	5922.00	738.63
Sad neutral accuracy	9.85	10.00	2.00	14.00	2.32
RT for correct sad neutral trials	2026.40	1805.00	984.00	6296.50	723.18
Very sad accuracy	3.67	4.00	0.00	6.00	1.16
RT for correct very said trials	2175.16	2047.00	0.00	5453.50	708.42

Table 7

Descriptive Statistics for the Low HA Group

Facial Memory Test	Mean	Median	Minimum	Maximum	SD
Accuracy	16.61	17.00	7.00	20.00	2.49
RT	1478.09	1417.50	711.00	3765.00	371.09
Emotion Discrimination Task					
Accuracy for happy trials	11.78	12.00	3.00	18.00	3.24
Accuracy for sad trials	13.64	14.00	3.00	18.00	2.474
RT for correct happy trials	4810.44	4383.00	1844.00	17109.00	2208.19
RT for correct said trials	3967.14	3695.50	1281.00	11109.00	1687.20
Emotion Recognition Task					
Accuracy	33.85	34.00	16.00	40.00	3.19
RT for accuracy	1899.14	1812.25	1203.00	4226.50	413.10
Accuracy for anger identifications	5.33	5.00	0.00	8.00	1.48
Accuracy for fear identifications	6.90	7.00	1.00	8.00	1.23
Accuracy for happy identifications	7.95	8.00	7.00	8.00	0.22
Accuracy for neutral identifications	6.82	7.00	2.00	8.00	1.36
Accuracy for sad identifications	6.86	7.00	1.00	8.00	1.27
RT for correct anger identifications	2337.59	2109.00	1141.00	8062.00	887.40
RT for correct fear identifications	2398.43	2129.00	765.50	8695.50	1092.46
RT for correct happy identifications	1539.66	1500.00	742.00	3281.00	294.41
RT for correct neutral identifications	2244.87	1988.00	961.00	13734.50	1143.38
RT for correct sad identifications	2035.94	1839.75	1063.00	7922.00	765.53
Accuracy for mild identifications	12.52	13.00	4.00	16.00	1.86
Accuracy for extreme identifications	14.53	15.00	5.00	16.00	1.49
RT for correct mild identifications	2005.79	1929.50	1250.00	4601.50	471.65
RT for correct extreme identifications	1782.36	1703.00	1094.00	4515.00	436.91
Emotional Acuity Test					
Accuracy	28.06	29.00	6.00	40.00	4.83
RT for accuracy	1852.79	1742.25	1039.50	3765.50	501.10
Very happy accuracy	4.29	4.00	1.00	6.00	1.25
RT for correct very happy trials	1784.64	1672.00	907.00	4054.50	511.94
Happy neutral accuracy	10.25	11.00	0.00	14.00	2.82
RT for correct happy neutral trials	1811.67	1640.50	953.00	4578.00	623.14
Neutral accuracy	15.15	16.00	1.00	20.00	3.61
RT for correct neutral trials	1843.26	1668.00	953.00	4632.50	625.36
Sad neutral accuracy	10.09	10.00	1.00	14.00	2.23
RT for correct sad neutral trials	1996.90	1828.00	976.00	6640.00	757.76
Very sad accuracy	3.44	3.00	0.00	6.00	1.35
RT for correct very said trials	2161.57	1945.50	1016.00	5460.50	744.82

Table 8

Descriptive Statistics for the High NS Group

Facial Memory Test	Mean	Median	Minimum	Maximum	SD
Accuracy	16.60	17.00	7.00	20.00	2.51
RT	1489.24	1398.50	711.00	3765.00	414.51
Emotion Discrimination Task					
Accuracy for happy trials	11.71	12.00	2.00	18.00	3.30
Accuracy for sad trials	13.66	14.00	4.00	19.00	2.36
RT for correct happy trials	4410.05	4047.00	1648.50	13718.00	1849.69
RT for correct said trials	3836.77	3539.00	1281.00	11766.00	1573.43
Emotion Recognition Task					
Accuracy	34.28	35.00	21.00	40.00	2.76
RT for accuracy	1834.96	1766.00	1257.50	3695.50	333.22
Accuracy for anger identifications	5.50	6.00	2.00	8.00	1.29
Accuracy for fear identifications	7.05	7.00	2.00	8.00	1.14
Accuracy for happy identifications	7.92	8.00	6.00	8.00	0.29
Accuracy for neutral identifications	6.83	7.00	2.00	8.00	1.44
Accuracy for sad identifications	6.98	7.00	1.00	8.00	1.08
RT for correct anger identifications	2284.66	2047.00	1093.00	8062.00	972.99
RT for correct fear identifications	2307.85	2093.50	765.50	8695.50	949.09
RT for correct happy identifications	1527.53	1492.00	742.00	3281.00	256.27
RT for correct neutral identifications	2115.26	1843.50	1125.00	13734.50	1069.40
RT for correct sad identifications	1924.35	1812.50	1109.50	7922.00	647.27
Accuracy for mild identifications	12.76	13.00	7.00	16.00	1.64
Accuracy for extreme identifications	14.69	15.00	8.00	16.00	1.18
RT for correct mild identifications	1972.56	1914.00	1265.00	3578.00	410.55
RT for correct extreme identifications	1754.44	1672.00	1094.00	4515.00	425.34
Emotional Acuity Test					
Accuracy	28.42	29.00	12.00	40.00	4.73
RT for accuracy	1780.74	1675.75	937.00	3765.50	438.25
Very happy accuracy	4.29	4.00	1.00	6.00	1.30
RT for correct very happy trials	1794.51	1687.50	765.00	4351.50	568.64
Happy neutral accuracy	10.43	11.00	0.00	14.00	2.93
RT for correct happy neutral trials	1717.07	1563.00	773.50	4578.00	561.30
Neutral accuracy	15.43	16.00	1.00	20.00	3.69
RT for correct neutral trials	1771.13	1601.50	735.00	4632.50	591.11
Sad neutral accuracy	10.20	10.00	2.00	14.00	2.25
RT for correct sad neutral trials	1923.89	1735.00	976.00	6640.00	689.21
Very sad accuracy	3.50	4.00	0.00	6.00	1.35
RT for correct very said trials	2100.53	1859.25	0.00	5172.00	745.97

Table 9

Descriptive Statistics for the Low NS Group

Facial Memory Test	Mean	Median	Minimum	Maximum	SD
Accuracy	16.75	17.00	8.00	20.00	2.43
RT	1527.49	1453.75	843.00	3235.00	389.44
Emotion Discrimination Task					
Accuracy for happy trials	11.55	12.00	3.00	18.00	3.46
Accuracy for sad trials	13.55	14.00	3.00	19.00	2.50
RT for correct happy trials	5015.15	4593.50	1570.50	17109.00	2194.49
RT for correct sad trials	4179.43	3703.00	1344.00	12734.00	1884.25
Emotion Recognition Task					
Accuracy	33.79	34.00	18.00	39.00	3.02
RT for accuracy	1939.19	1844.00	1203.00	4226.50	428.37
Accuracy for anger identifications	5.29	5.00	0.00	8.00	1.47
Accuracy for fear identifications	6.99	7.00	2.00	8.00	1.18
Accuracy for happy identifications	7.94	8.00	7.00	8.00	0.25
Accuracy for neutral identifications	6.72	7.00	0.00	8.00	1.53
Accuracy for sad identifications	6.86	7.00	1.00	8.00	1.22
RT for correct anger identifications	2333.67	2124.75	0.00	5500.00	843.77
RT for correct fear identifications	2436.94	2148.00	1172.00	8656.00	1062.86
RT for correct happy identifications	1547.36	1507.75	945.50	3360.00	275.21
RT for correct neutral identifications	2319.35	1984.00	961.00	9773.00	1080.43
RT for correct sad identifications	2095.26	1941.25	1063.00	5562.50	671.84
Accuracy for mild identifications	12.53	13.00	7.00	16.00	1.74
Accuracy for extreme identifications	14.55	15.00	6.00	16.00	1.50
RT for correct mild identifications	2049.91	1964.50	1250.00	4601.50	515.45
RT for correct extreme identifications	1812.66	1718.75	1157.00	3367.00	405.89
Emotional Acuity Test					
Accuracy	27.60	28.00	6.00	38.00	4.66
RT for accuracy	1925.01	1801.00	992.00	3640.50	499.86
Very happy accuracy	4.40	4.50	0.00	6.00	1.19
RT for correct very happy trials	1798.97	1703.00	907.00	3578.50	486.47
Happy neutral accuracy	9.83	10.00	1.00	14.00	2.58
RT for correct happy neutral trials	1946.97	1730.25	891.00	8250.00	785.58
Neutral accuracy	14.72	15.00	2.00	20.00	3.40
RT for correct neutral trials	1959.97	1765.50	875.00	5922.00	729.91
Sad neutral accuracy	9.77	10.00	1.00	14.00	2.28
RT for correct sad neutral trials	2103.78	1937.50	984.00	6296.50	795.93
Very sad accuracy	3.61	4.00	0.00	6.00	1.17
RT for correct very said trials	2236.35	2172.00	945.00	5460.50	702.02

It was expected that, since High HA is characterized by, amongst others, enhanced attention and vigilance, the High HA group would score higher on all stimulus conditions than the Low HA group. Contrary to these expectations and as indicated by the means in Tables 6 and 7, the High HA group performed higher on only nine of the eighteen stimulus conditions, and their response times were faster on only seven variables. On the Facial Memory Test (CPF) the High HA group scored higher than the Low HA group on both stimulus and response time, but scored higher on only one of the five variables in the Emotion Discrimination Test (EDF40). On the Emotion Recognition Test (ER40) the High HA group scored higher on seven of the sixteen variables, and seven of the fourteen variables in the Emotional Acuity Test (PEAT40).

Differences were also found between the results of the High NS and Low NS group. As expected, the Low NS group scored higher on the Facial Memory Test than the High NS group. The response time of the High NS group was, however, faster than the Low NS group. The High NS group performed better on the Emotion Discrimination Test (EDF40) and the Emotion Recognition Test (ER40), and had faster response times on the Emotional Acuity Test (PEAT40), scoring higher on five of the seven variables in that test.

4.3. STATISTICAL ANALYSES

The non-parametric Mann-Whitney rank sum test was decided upon as the main method of analysis as it is more effective when dealing with skewed data, and the sample in this study was considered large enough to yield powerful results. The Mann-Whitney is used to compare two independent groups based on a single variable, and uses the ranks of the study variable rather than actual values, which means that extreme values have less influence on the results (Maree, 2010). The use of this statistic is therefore justified since outliers were present in the data.

In order to determine the effect that variable trait indices might have on the emotions tasks, multivariate analysis of variance (MANOVA) was also conducted. MANOVA counters the experiment-wise or family-wise error which increases when multiple but independent tests of differences are conducted and the probability of type I errors is thus decreased. In addition to this, if dependent variables are in some way correlated with each other, conducting separate analyses of difference may not yield the most accurate depiction. Highly inter-correlated and highly uncorrelated dependent variables are, however, not optimal for use within a MANOVA. The various emotions batteries in the PennCNP range from low to moderately correlated justifying the use of this statistic (Gur et al., 2010). Exploring the emotions data separately within each variate allows for finetuning in terms of detecting any effect that may be masked by variance accounted for simultaneously when all the variates are included.

4.4. WITHIN TRAIT VARIABILITY

4.4.1 High HA and Low HA

Mann-Whitney U tests revealed moderately significant differences between high and low HA on two variables (see Table 10). On the Emotion Recognition Task the High HA group was more accurate than the Low HA group when recognising fearful expressions. The High HA group was also more accurate on the Emotional Acuity Test when discriminating between emotional valence of very sad expressions and neutral expressions than the Low HA group. Multivariate analyses revealed no significant differences between the two groups in emotional processing.

Table 10

Differences Between High HA and Low HA Groups

Emotions	Z	p-value	N High	N Low
Fear C	1.84	0.066	213	214
VSN C	1.78	0.074	212	214

VSN-very sad neutral; C-correct responses

The following graphical representations (Figures 4.1 and 4.2) are used to illustrate the mean, median and outliers for the moderately significant variables VSN and Fear C:

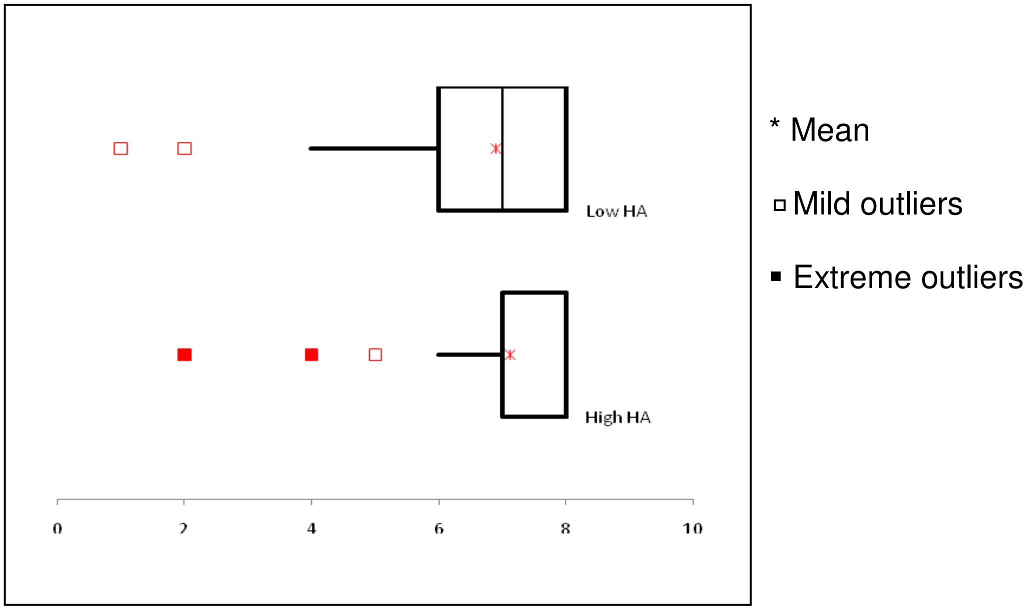

Figure 4.1: Box-Whisker Plot for Fear C responses (ER40)

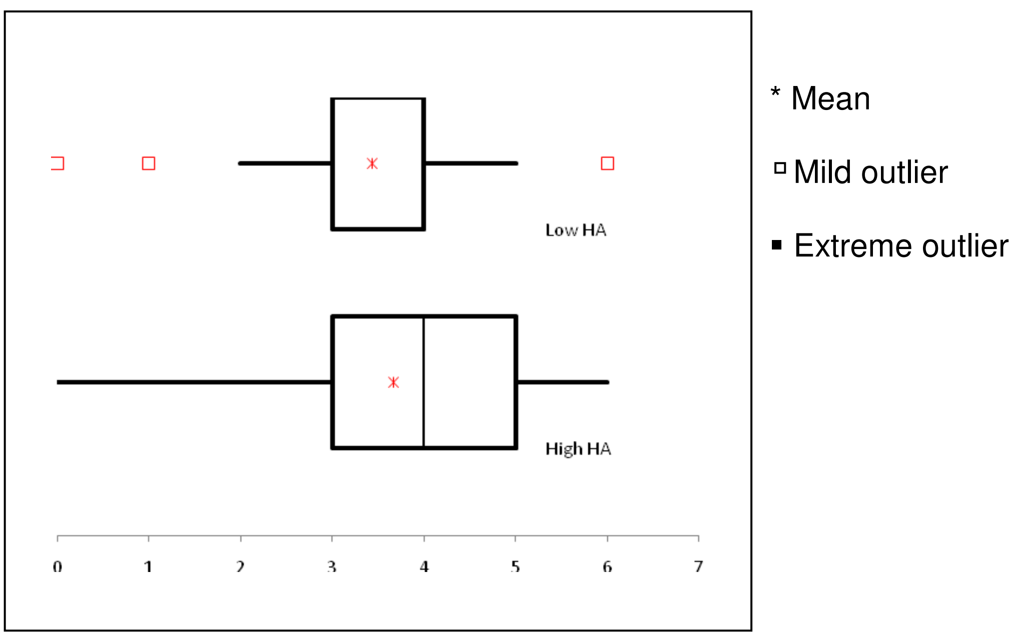

Figure 4.2: Box-Whisker Plot for VSN correct responses (PEAT40)

4.4.2 High NS and Low NS

The Mann-Whitney U tests revealed significant differences between the High and Low NS groups in tasks measuring emotion recognition, emotion discrimination between intensity of positive and negative emotions, and in recognising and discriminating between emotional valence of happy and sad facial expressions to neutral facial expressions (see Table 11). Multivariate analysis revealed no significant differences between the two groups when including all the emotion variates. Although not significant at the established 5% level of significance, when the analyses were run for emotion variates within each test differences were found between the NS groups on the Emotion Discrimination Task for emotion discrimination of happy and sad faces [$F(5,424)=2.17$, $p=0.06$, $\eta^2=0.03$] and on the Emotional Acuity Test for discerning emotional acuity and intensity of happy from neutral faces and sad from neutral faces [$F(12,410)=1.66$, $p=0.07$, $\eta^2=0.05$].

Table 11

Differences Between High NS and Low NS Groups

Emotions	Z	p-value	N High	N Low
Happy RT	3.10	0.002	199	231
Total RT-ER40	2.34	0.019	199	232
N RT	2.60	0.009	199	231
S RT	3.10	0.002	199	232
Total C-PEAT40	-2.20	0.028	198	232
Total RT-PEAT40	3.33	0.001	198	232
HN C	-2.87	0.004	198	232
HN RT	3.84	0.000	197	232
N C	-2.73	0.006	198	232
N RT	3.21	0.001	198	232
SN C	-2.00	0.043	198	232
SN RT	2.52	0.012	198	232
VSN RT	2.78	0.005	194	231

VSN-very sad-neutral; N-neutral; S-sad; HN-happy-neutral; SN-sad-neutral; C-correct responses; RT-reaction time

The following graphical representations (Figures 4.3 to 4.15) are used to illustrate the mean, median and outliers for the significant variables:

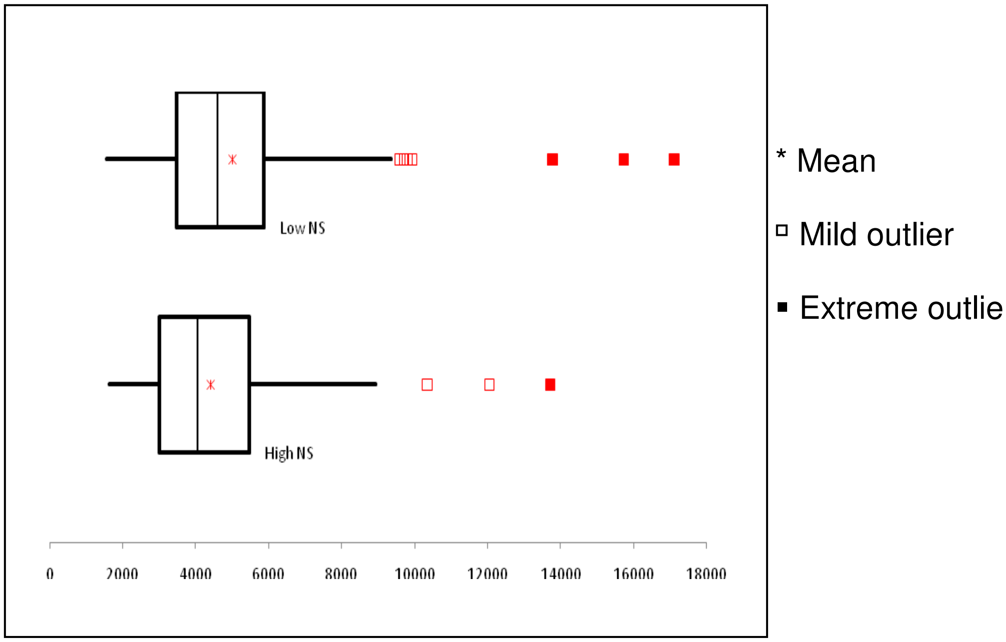

Figure 4.3: Box-Whisker Plot for Happy RT (EDF40)

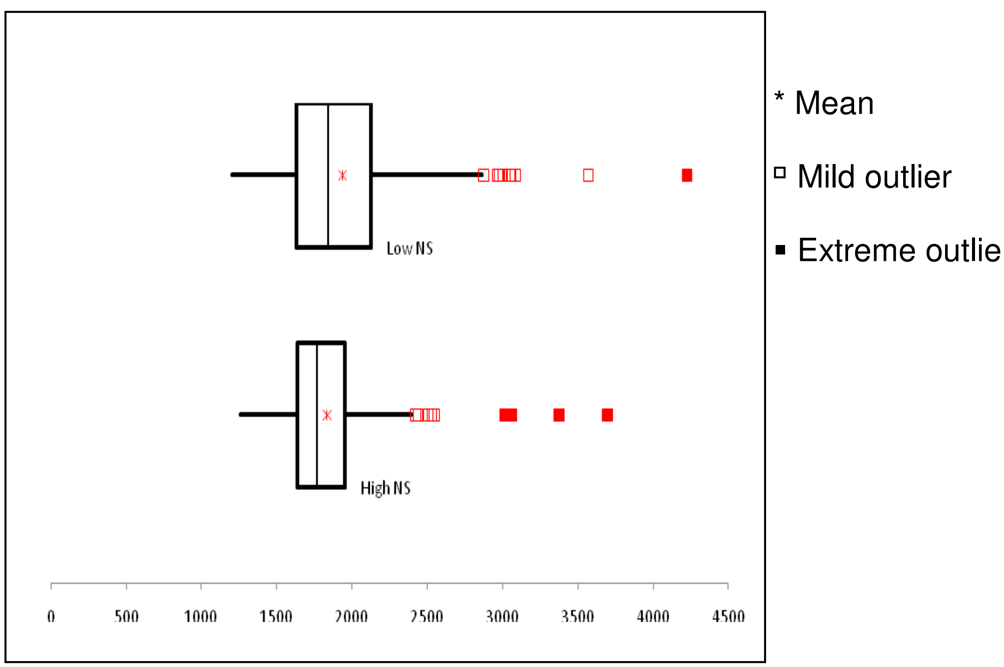

Figure 4.4: Box-Whisker Plot for total RT (ER40)

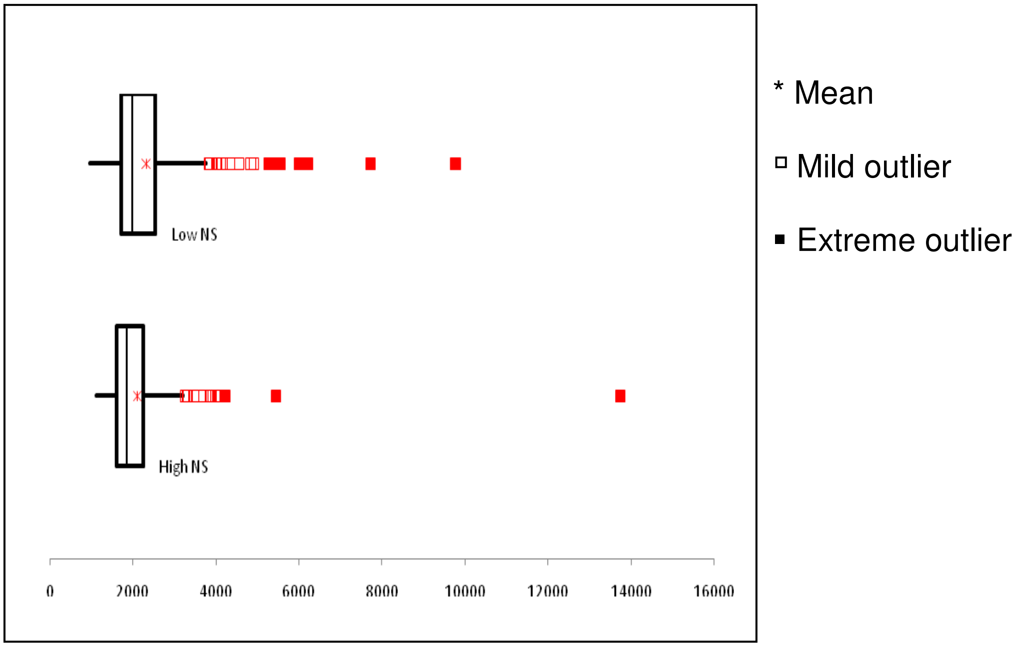

Figure 4.5: Box-Whisker Plot for correct N RT (ER40)

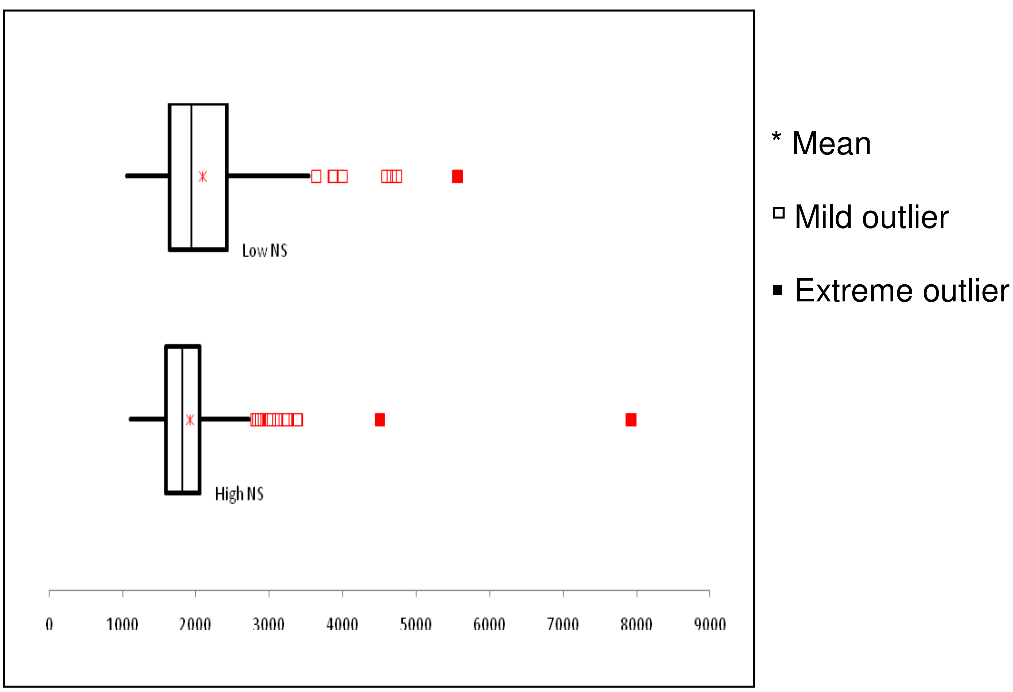

Figure 4.6: Box-Whisker Plot for correct S RT (ER40)

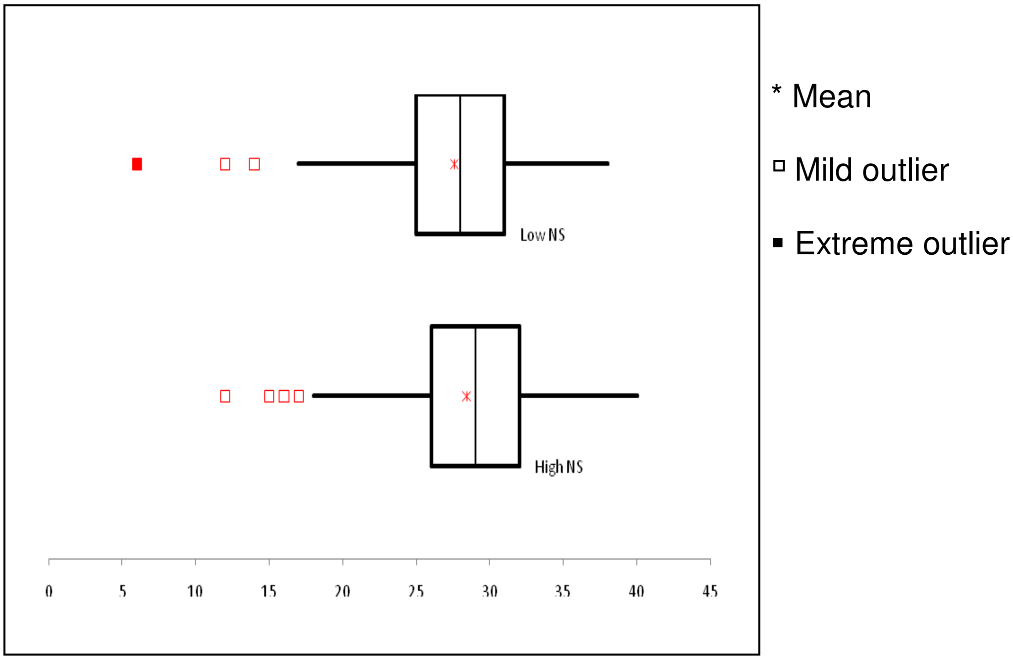

Figure 4.7: Box-Whisker Plot for Total C (PEAT40)

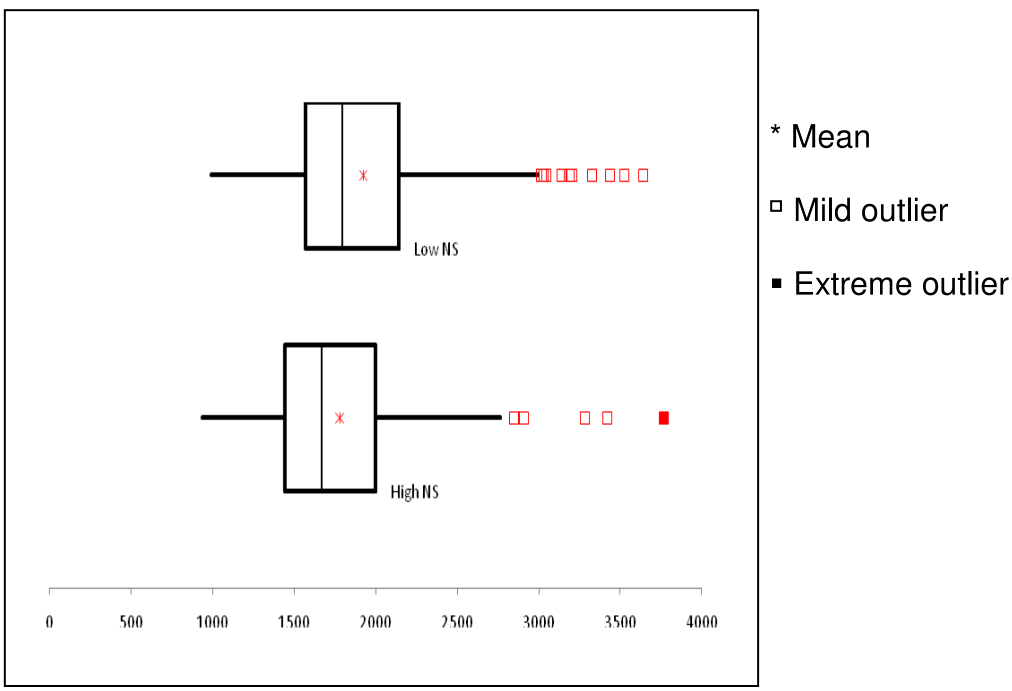

Figure 4.8: Box-Whisker Plot for Total RT (PEAT40)

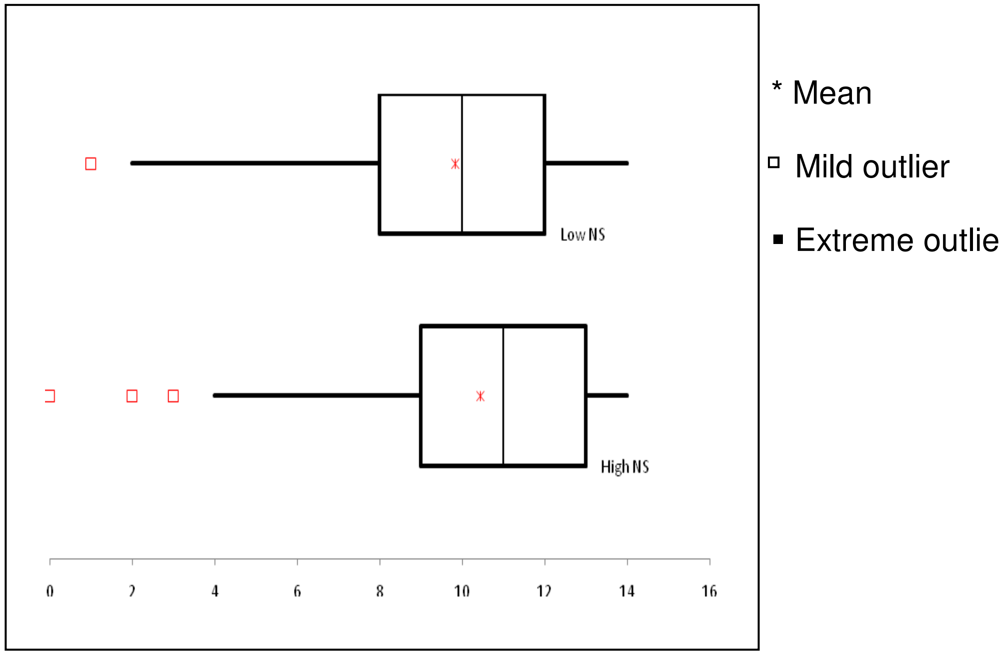

Figure 4.9: Box-Whisker Plot for HN C responses (PEAT40)

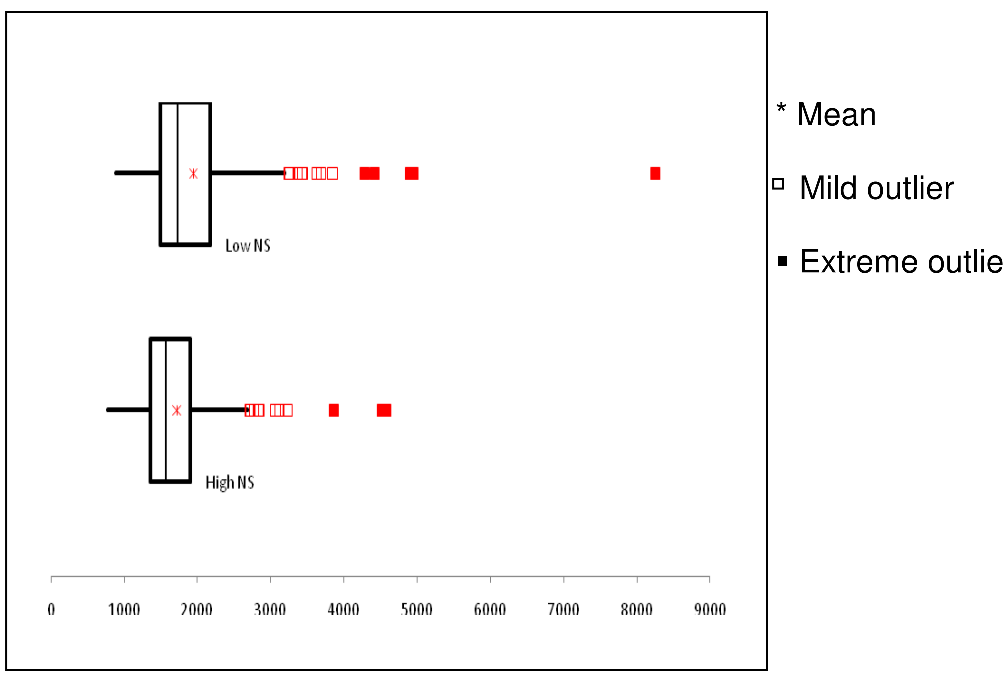

Figure 4.10: Box-Whisker Plot for HN RT (PEAT40)

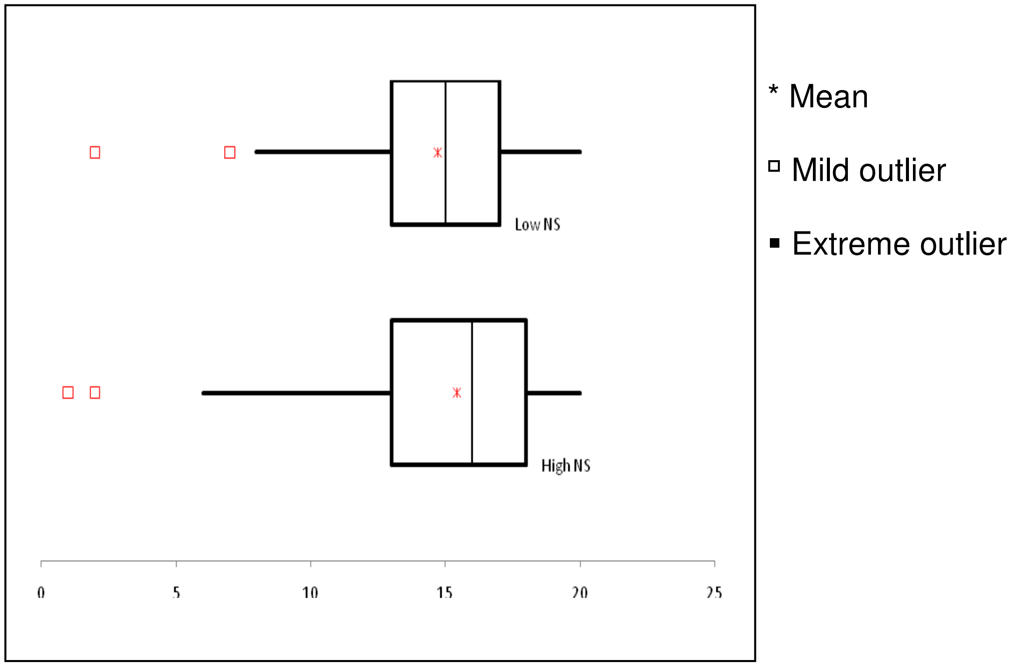

Figure 4.11: Box-Whisker Plot for N C responses (PEAT40)

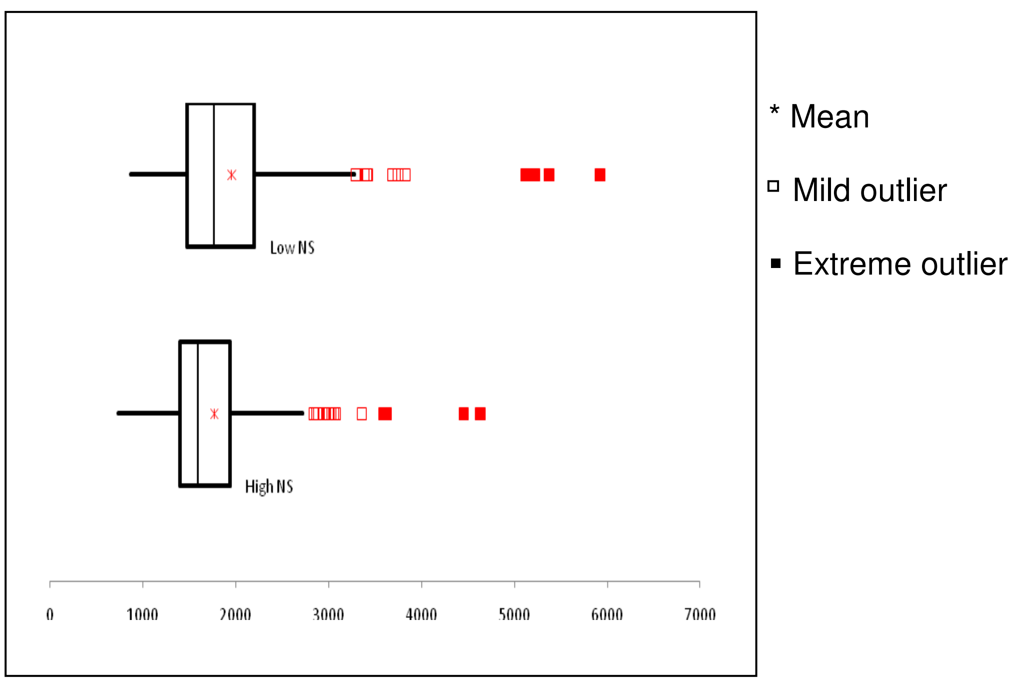

Figure 4.12: Box-Whisker Plot for correct N RT (PEAT40)

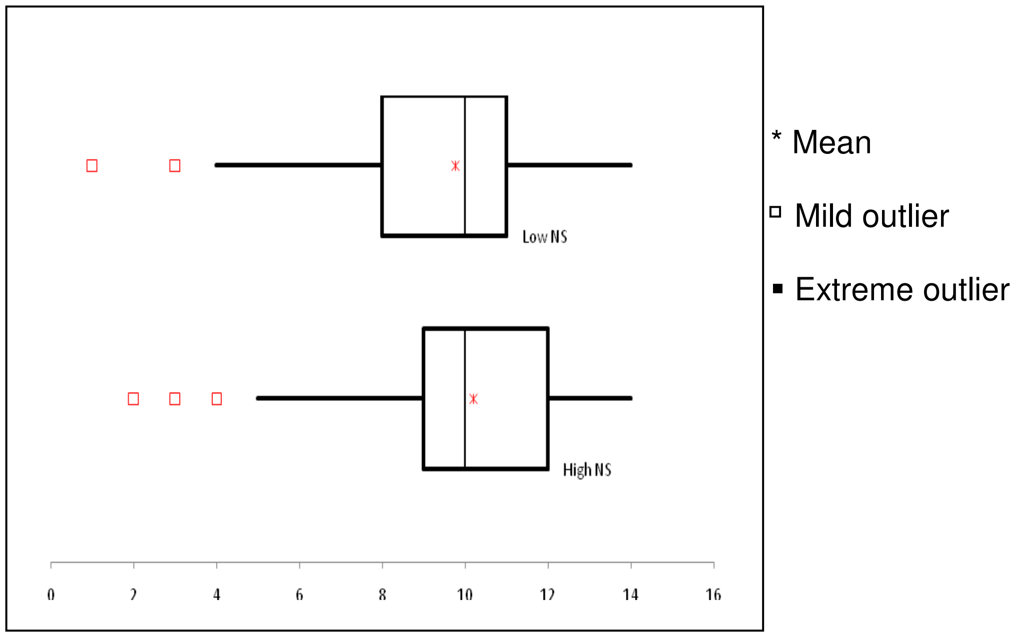

Figure 4.13: Box-Whisker Plot for SN C responses (PEAT40)

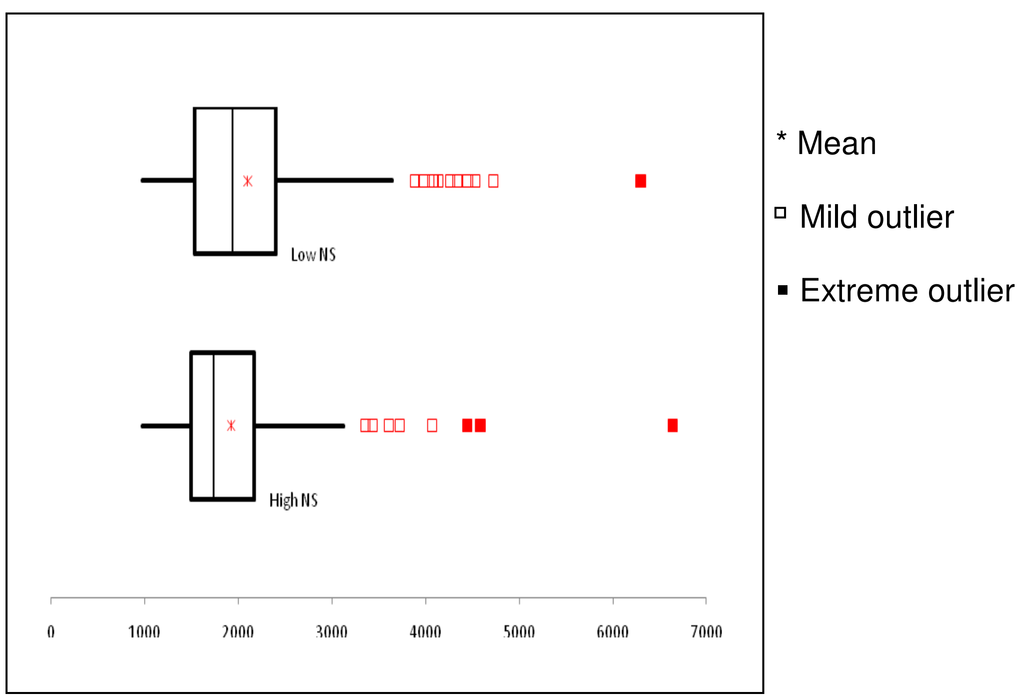

Figure 4.14: Box-Whisker Plot for correct SN RT (PEAT40)

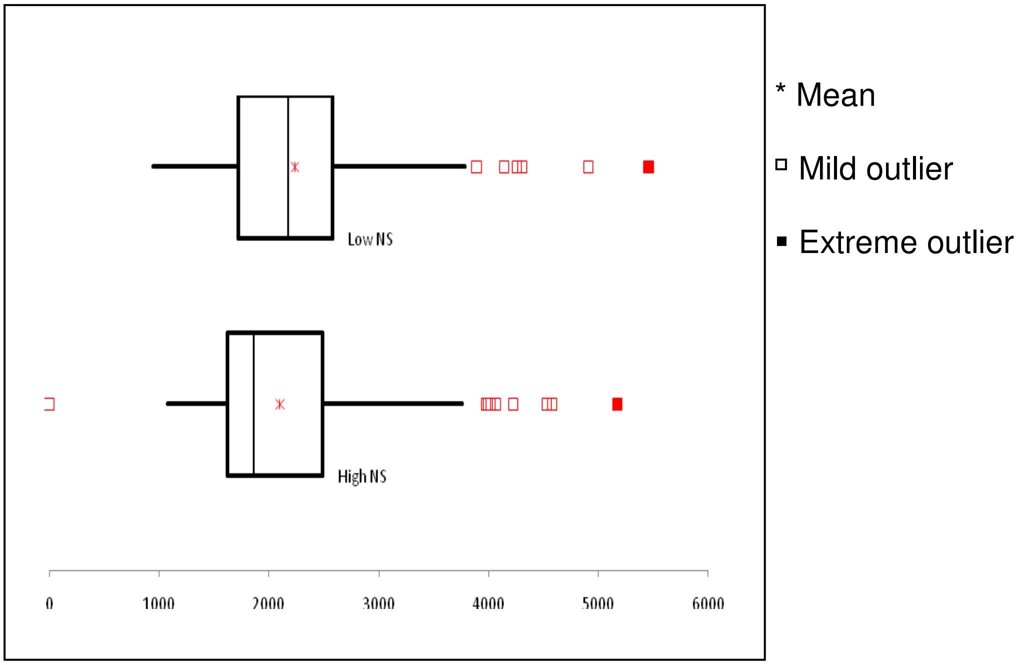

Figure 4.15: Box-Whisker Plot for VSN RT (PEAT40)

4.5 CONCLUSION

Univariate analysis revealed that there are moderately significant differences between high and low HA, specifically in the recognition of fear, and discrimination between emotional valence of very sad and neutral emotions. However, multivariate analyses revealed no significant differences between High and Low HA groups.

Univariate analysis revealed significant differences between high and low NS, specifically in the discrimination of happy emotions on the Emotion Discrimination Task, the recognition of sad and neutral emotions on the Emotion Recognition

Task, and emotion recognition and discrimination by valence of happy to neutral, sad to neutral and very sad to neutral faces on the Emotional Acuity Test. Multivariate analysis revealed moderately significant differences for discrimination of happy and sad faces on the Emotion Discrimination Task and discerning emotional valence and intensity of happy from neutral and sad from neutral faces in the Emotional Acuity Test. The results will be discussed in more detail in Chapter 5.

CHAPTER 5

DISCUSSION

5.1. INTRODUCTION

The aim of this study was to determine whether differences within each of the two temperament traits HA and NS influenced the processing of emotional facial stimuli. The research questions were therefore to determine whether groups:

i) High and low in HA perform differently on tasks of emotional recognition and emotional discrimination;

ii) High and low in NS perform differently on tasks of emotional recognition and emotional discrimination.

The results were analysed using univariate analysis (Mann-Whitney U test) and multivariate analysis of variance (MANOVA). Various degrees of support were found for the two research questions and this chapter provides a discussion of the results as obtained from the data analysis. The chapter will also take account of the strengths and limitations of this study, give recommendations for future research and offer a final conclusion.

5.2 TEMPERAMENT DIMENSIONS

To recapitulate, HA is a temperament dimension that Cloninger (1987) identified as encapsulating an individual's tendency to react strongly to signals of aversive stimuli, and consequently inhibit or cease behaviour. Therefore, high HA individuals are characterised as apprehensive, shy, pessimistic and prone to fatigue whereas low HA individuals are characterised as carefree, relaxed, courageous, composed and optimistic, even in situations that might have cause for concern (Van Berkel, 2009).

NS is a temperament dimension that Cloninger (1987) identified as encapsulating an individual's tendency to move appetitively to novel stimuli and actively avoid punishment. Therefore, high NS individuals are characterised as exploratory, excitable, curious, enthusiastic, exuberant, easily bored and quick-tempered, whilst low NS individuals are characterised as slow-tempered, stoical, uninquiring, unenthusiastic and tolerant (Svrakic et al., 1992).

5.2.1 *Harm Avoidance*

The results of the univariate analysis revealed that high HA was associated with accurate identification of fearful facial expressions in the Emotion Recognition Task. High HA was also found to be associated with a processing bias for very sad as compared to neutral facial expressions when compared to the Low HA group in the Emotional Acuity Test. Since

HA is believed to be associated with fear and anxiety, individuals high in HA would conceivably be more alert to indications of danger and therefore have a more significant response to negative emotional expressions. This is consistent with the belief that individuals high in HA have a tendency to respond intensely to signals of aversive stimuli (Miettunen et al., 2006). According to Vuilleumier et al., (2003, p. 624) “expedient detection of fear-related cues is critical for survival”. This assertion is confirmed by Miskovic and Schmidt (2010, p. 501) who state that signals of threat “have preferential access to attentional resources”.

Heightened arousal and vigilance caused by fear and anxiety would therefore lead individuals high in HA to be more alert to signals of threat, which would, in turn, reflect in their ability to identify negative emotional expressions. Research by Pickett and Kurby (2009) found that individuals scoring higher on experiential avoidance showed a bias toward activating negative emotion inferences. This is consistent with results by De Pascalis et al. (2004), who found that anxious individuals are more sensitive to negative emotional stimuli. The results of the present study support this evidence, as the High HA group was shown to be associated with recognising fearful and very sad facial expressions.

Cloninger et al. (2006), in a study assessing whether personality can predict future depression, found that high HA is strongly predictive of an emotional vulnerability to depression. This may be as a result of the fact that harm-avoidant traits reflect variations in the BIS, or "the brain's punishment system" (Cloninger, 1987, p. 576), which includes the serotonergic projections from the raphe nuclei in the brain stem and cholinergic projections to the frontal neocortex. Cloninger (1987, p. 576) argues that the ascending serotonergic projections "are essential for conditioned inhibition of activity by signals of punishment and frustrative nonreward". Cloninger (1987, p. 576) further states as follows:

> *"In response to novel stimuli that are not paired with rewards or relief of punishment, cholinergic projections from the ventral tegmental area and the basal nucleus of the amygdala excite the frontal cortex and stimulate release of stress hormones such as corticotropin and cortisol. In turn, frontostriatal projections reduce exploratory activity by inhibiting dopaminergic neurons in the caudate nucleus."*

Amodio et al. (2008) supports Cloninger's view by arguing that the BIS framework relates to the inhibition of behaviour in reaction to a stimulus rather than the deliberate process of inhibitory control, and strong BIS, through its association with enhanced attention, anxiety, arousal and vigilance, corresponds to anxiety-related disorders. Van Berkel (2009) further confirms Cloninger's assertions by stating that high HA has been associated with a biased BIS and lower serotonin levels, which have been linked to depressive symptoms.

The results of the present study indicate that high HA is associated with a processing bias for negative emotional stimuli. Negative emotional processing biases have been implicated in the development and maintenance of psychopathologies such as Panic Disorder, Generalised Anxiety Disorder or Major Depressive Disorder (Harmer et al., 2008; Ladouceur et al., 2005). Specifically, Ladouceur et al. (2005), in a study on altered emotional processing and depression, found altered processing of emotional stimuli to be particularly associated with depression. Therefore, differences within the HA trait can be seen as a possible predisposing factor to certain psychopathologies.

In line with Vuilleumier et al., (2003) and Yoshino et al. (2005), and given that individuals high in HA have higher vigilance and arousal, it was expected that pre-semantic perceptual processing would influence the response times of the High HA group, especially on the negative emotional expressions such as fear, anger and sadness. Contrary to these expectations the High HA group did not have statistically significant response times on any of the emotional stimuli. The High HA group also did not score higher than the Low HA group on all stimuli conditions, as found by Yoshino et al. (2005).

Of importance is that multivariate analysis revealed no significant differences between the two HA groups. This may result from the fact that the faces presented as stimuli are unfamiliar to the participants. According to Posamentier and Abdi (2003), differential activation patterns have been found in the processing of known and unknown faces. They state that the amygdala responds to faces in general, assessing the possible threatening valence of stimuli, and that unknown faces may initially be processed as possible threatening stimuli, whereas known faces do not present a threat. Beaton et al. (2008) corroborate the idea that presentation of a stranger face may attenuate the processing of the specific valence conveyed in facial emotional expressions.

5.2.2 *Novelty Seeking*

According to the literature, responses to emotional expressions reflect either an approach or avoidance motivation (Adams et al., 2006; Carver & Harmon-Jones, 2009; Harmon-Jones, 2003). Elliot and Covington (2001) state that such approach or avoidance is a predisposition, generated by temperament traits, which influence the automatic processing of stimuli. Bermpohl et al. (2008) found that the exploratory excitability dimension of NS modulated brain activity in the medial prefrontal cortex (MPFC) during the anticipation of emotional stimuli. The authors state that their findings are consistent with neuroimaging studies implicating the MPFC in types of "reward anticipation and appetitive states" (Bermpohl et al., 2008, p. 84). Based on a review of the literature it was therefore expected that the High NS group would show faster response times on all the emotional stimuli since individuals high in NS have a tendency to act impulsively, and are seen to respond appetitively to novel stimuli or potential rewards. The data revealed that the High NS group did indeed perform faster than the Low NS group on all the emotional stimuli. The High NS group was, therefore, able to recognise and discriminate between emotional expressions faster than those low in NS, but it should be noted that analyses did not always reveal statistically significant results. The results of the univariate and multivariate analyses will be discussed by test as hereunder.

- *Facial Memory Test*

  In the Facial Memory Test participants were shown a series of twenty faces which they would later have to identify. During the recall participants were shown a series of forty faces, including twenty novel faces and the twenty faces they were asked to memorise. Participants were then required to indicate whether or not they had seen the specific face before.

According to Cloninger (1987), active avoidance of monotony is a characteristic of high NS. Such avoidance of monotony, together with impulsiveness, could cause individuals high in NS to hasten through stimuli regarded as difficult or tedious, regardless of consequence. In line with this it was expected that the High NS group would score lower in the Facial Memory Test since high NS is characterised by impulsiveness and easy boredom (Cloninger, 1987). As expected, the data showed that the Low NS group scored higher in terms of correct responses when compared to the High NS group. It should be noted, however, that the difference did not prove to be statistically significant in either the univariate or the multivariate analyses.

- *Emotion Discrimination Task*

  In the Emotion Discrimination Task participants were presented with a pair of faces and required to convey their view as to which face expressed a given emotion more intensely, or whether both faces were equally emotional.

Univariate analysis revealed that the High NS group was significantly faster when discriminating between happy faces in the Emotion Discrimination Task (p=0.002), while multivariate analysis revealed moderately significant results for emotion discrimination of both happy and sad facial expressions [$F(5,424)=2.17$, $p=0.06$, $\eta^2 =0.03$]. The univariate analysis did not confirm the significant results for sad facial expressions.

According to Posamentier and Abdi (2003) the smile is the most easily recognised expression, even though to date neuroimaging studies have not found consistent patterns of activation when responding to smiling faces. Happy facial expressions can, however, be seen as positive emotional stimuli and, given that individuals high in NS are characterised by Cloninger (1987) as enthusiastic and exploratory, it is feasible that they would respond faster to positive emotional stimuli than the characteristically unenthusiastic low NS individuals. In line with this Adams et al. (2006) state that joy conveys a heightened likelihood of approach by the observer.

Posamentier and Abdi (2003) further state that the perception of emotions such as sadness is closely related to the concept of empathy. Even though sadness is classified as a negative emotion it does not communicate a threat, as, for example, fear and anger does (Adams et al., 2006). Therefore, sadness elicits approach rather than avoidance in the appetitive high NS individuals as opposed to the uninquiring low NS individuals.

NS has been associated with Antisocial Personality Disorder (Cloninger & Svrakic, 1997), which is characterised by, amongst others, a lack of empathy (Sue et al., 2003). The significant results for discrimination of sad facial expressions by the High NS group would therefore seem inconsistent. According to Knyazev et al. (2008, p. 1093), "psychometric measures of impulsiveness show high correlations with traits such as sensation seeking and anti-social or nonconformist tendencies". The authors state that for this reason Pickering and Gray (cited in Knyazev et al., 2008) assumed the term Impulsive Antisocial Sensation Seeking as a label for the BAS-related personality dimension. Similarly, Zuckerman (cited in Sue et al., 2003) believes that his trait Impulsive Unsocialised Sensation Seeking (IUSS) can help explain Antisocial Personality Disorder (APD). According to Zuckerman (cited in Sue et al., 2003), individuals with the IUSS trait seek adventure and thrills, are disinhibited and easily bored. As previously described in Chapter 2, the IUSS has been highly correlated to Cloninger's NS trait.

The commonality in Gray's, Zuckerman's and Cloninger's traits is a sensation or thrill-seeking dimension. Farley (cited in Sue et al., 2003) proposes that thrill-seeking individuals have lower central nervous system arousal levels, and that individuals with low intensity central nervous system arousal require higher levels of stimulation to maintain optimal levels of arousal. This is confirmed in an EEG study by Gale et al. (2001), who found that extraverts showed low cortical arousal levels. This type of stimulation can either be constructive, as seen in adventurers and physical risk takers, or destructive, as seen in violent delinquents and criminals (Sue et al., 2003). The difference between the individual with APD who is a risk-taker and the individual who is an adventurer, is mostly related to whether the stimulus-seeking behaviours are channelled constructively or destructively (Sue et al., 2003). Therefore, the aspect of NS which could predispose an individual to APD is not related to a lack of empathy, but rather the thrill-seeking which stems from a need for higher stimulation due to the low central nervous system arousal levels. In light of the above the significant results for discrimination of sad facial expressions by the High NS group is therefore consistent when considering that sadness elicits approach rather than avoidance in the appetitive high NS individuals.

- *Emotion Recognition Task*

In the Emotion Recognition Task participants were shown a series of forty faces and asked to determine what emotion each face was depicting. The emotions to choose from where happy, sad, anger, fear and no emotion (neutral).

Multivariate analysis did not reveal statistically significant results when analysing the Emotion Recognition Task. According to the univariate analysis, however, the High NS group was significantly faster when correctly identifying sad and neutral facial expressions on the Emotion Recognition Task when compared to the Low NS group (p=0.002 and p=0.009, respectively). Furthermore, the High NS group was also significantly faster than the Low NS group in the overall correct responses on the Emotion Recognition Task (p=0.019). This suggests that the High NS group was more adept at quickly recognising particular emotions, but particularly sad and neutral emotions. According to Habel et al. (2007) the capacity to recognise emotions in facial expressions accurately is critical in social communication and, evolutionarily, is imperative for survival.

Since individuals high in NS are more exploratory and inquisitive than the stoical low NS individuals, it is feasible that they are more vigilant and therefore interpret incoming stimuli more rapidly, thereby recognising specific emotions faster than the low NS group. As stated before, sadness is related to empathy and may elicit approach in an observer (Posamentier & Abdi, 2003). Neutral facial expressions indicate no threat and therefore do not elicit an avoidance motivation in socially disinhibited individuals. The High NS group would therefore conceivably respond faster on both sad and neutral expressions during the Emotion Recognition Task.

- *Emotional Acuity Test*

  During the Emotional Acuity Test participants were shown a series of forty faces, presented in two blocks containing sad and neutral faces (sad-neutral block), and happy and neutral faces (happy-neutral block). Participants were instructed to rate each face according to emotional valence on a seven-point scale ranging between very sad, moderately sad, somewhat sad, neutral, somewhat happy, moderately happy and very happy.

Posamentier and Abdi (2003) believe faces constitute the most important stimuli in social interactions. The authors state that not only is it important to identify the face as belonging to a specific individual, but facial expressions also have to be interpreted for emotional context, "which sets the tone for social interaction" (Posamentier & Abdi, 2003, p. 113).

Univariate analysis revealed that for correct responses the High NS group was better at rating the emotional valence on happy from neutral ($p=0.004$), neutral ($p=0.006$), and sad from neutral expressions ($p=0.043$). The High NS group also had significantly higher total correct responses than the Low NS group ($p=0.028$). In addition, univariate analysis revealed that, in terms of response times, the High NS group was faster when rating emotional valence on total correct responses ($p=0.001$), happy-neutral responses ($p<0.01$), neutral responses ($p=0.001$), sad-neutral responses ($p=0.012$) and very sad-neutral responses ($p=0.005$).

Multivariate analysis revealed significant differences on the Emotional Acuity Test when rating emotional valence of happy from neutral facial expressions, and sad from neutral facial expressions [$F(12,410)=1.66$, $p=0.07$, $\eta^2=0.05$].

Consistent with the findings by Yoshino et al. (2005), it was expected that the High NS group would respond significantly higher than the Low NS group to high-arousal stimuli (both positive and negative emotional expressions) since high NS is characterised by thrill-seeking and exploration (Cloninger, 1987). Both univariate and multivariate results confirmed that the High NS group scored significantly higher for both the happy neutral and sad neutral trials on the Emotional Acuity Test, indicating that they were better at discriminating between valence of happy and neutral emotions, and sad and neutral emotions, respectively. The slower response times of the Low NS group imply that the Low NS group was less vigilant when discriminating between happy and neutral, and sad and neutral facial expressions.

Since high NS is associated with thrill-seeking, and given the results of studies by Yoshino et al. (2005) and Bermpohl et al. (2008), it was expected that the High NS group would not respond significantly to neutral emotional stimuli. Contrary to these expectations the results of both the univariate and multivariate analysis revealed that the High NS group did in fact have significant responses for neutral emotional stimuli (correct responses and response times). A possible explanation for the significant results relating to the neutral stimuli is that since individuals high in NS are characterised by exploration and impulsivity, the High NS group responded faster to all the emotional stimuli, regardless of specific emotion, because the experience was novel. Another possible explanation for the significant neutral responses is that neutral facial expressions indicate no threat and therefore elicit neither an approach nor avoidance motivation in the observer. Individuals high in NS, characterised by exploratory activity and approach behaviour, would therefore have faster response times than those low in NS, characterised by stoicism and tolerance.

The results suggest that the High NS group was significantly faster when discriminating between the valence of positive and neutral, and negative and neutral expressions as compared to the Low NS group. The faster response times of the High NS group suggests a measurable indication of the appetitive state and exploratory nature of NS as described by Cloninger (1987).

The significant results in the univariate analysis for overall correct responses and their response times on the Emotional Acuity Test indicate that the High NS group showed a greater ability to differentiate between different emotional valences and could do so faster than the Low NS group. The results also indicate that the High NS group was better at identifying and discriminating between mildly valenced emotions in the happy / neutral and sad / neutral trials. They were, in other words, better able to distinguish between slight variations in happy and sad emotional expressions than the Low NS group. Adams et al. (2006) claim that recognition and discrimination of emotion is critical for social interaction. The results indicate that the High NS group was better able to recognise and discriminate between different emotional expressions. This suggests that individuals high in NS are better at social interaction than those low in NS, characterised by Cloninger (1987, p. 576) as “highly slow to form and change interests and social attachments”.

5.2.3 Summary

According to the literature, processing of faces and facial expressions is very important for social interaction, and both lesion and clinical studies have shown that the processing of faces and facial expressions can be impaired in certain clinical groups (Posamentier & Abdi, 2003). The findings of the present study suggest a negative emotion processing bias in the High HA group as opposed to the Low HA group. This is consistent with findings by Knyazev et al. (2008), who states that empirical evidence has shown that anxiety is related to a sensitivity to negative emotional faces.

The findings further suggest that, as a result of the specific characteristics of individuals high in NS, the High NS group reacted more appetitively to emotional stimuli than the Low NS group. Contrary to expectations, the High NS group had significant responses for neutral emotional stimuli in both the Emotion Recognition Task and the Emotional Acuity Test. Significant responses for both positive and negative emotions indicate that the results are in line with Bermpohl et al. (2008), who found that NS did not show an affective processing bias for either positive or negative emotions during picture perception.

5.3 STRENGTHS AND LIMITATIONS

Some strengths and limitations of this study should be noted. The Mann-Whitney U test uses the ranks of the study variable rather than the values, which means that outliers have less influence on the results (Maree, 2010). Since the data of the present study was skewed, the use of the Mann-Whitney U test provided more robust results than the use of, for example, an independent t-test would have done. However, because the procedure is non-parametric it becomes more difficult to make quantitative statements about the actual difference between populations. This has been counteracted by the use of MANOVA as an additional statistical procedure to prevent against type I errors.

The use of self-report measures, such as the TCI, has a number of strengths and limitations associated with it. Van Berkel (2009) states that the majority of studies focussing on personality gather data through the use of self-report measures, and it is therefore easier to compare studies using similar methodologies. According to Cloninger et al. (1993) self-report measures for rating dimensions of personality have been developed using factor analysis, which has been shown to be reliable and correlate highly with one another. Self-report measures have also been shown to be consistent with independent reports from spouses and other informants. Self-report measures negate the need for clinicians to conduct extensive interviews, as they have been shown to explain a good deal of the variation in such interview diagnoses (Cloninger et al., 1993). A limitation of self-report measures is often its length. The TCI has 238 items and it is possible that participants may tire as they progress, with the result that responses may become less reliable. It is also possible that participants may make mistakes when completing the questionnaire due to misunderstandings. The sample of the present study comprised educated individuals (university students) who came from educated backgrounds, thereby minimising a risk of misunderstandings when completing the questionnaire.

The study has the following limitations:

- Due to the practical implications of using an internet based computerised testing battery, the sample was one of convenience and the results can therefore not be generalised reliably to other populations.

- The convenience sample had a biased gender ratio with a high female to male disparity. According to Kashdan and Hofmann (2008) research has shown that women report lower levels of traits associated with NS like impulsivity and risky behaviour. The authors found that whilst men were fairly evenly distributed between the low and high NS groups, women were less likely to be in the high NS group. Van Berkel (2009) argues that the high female to male ratio is typical for studies which sample from psychology students and suggests that such limitations can be addressed by including a different subgroup, such as engineering students, which is traditionally a more male oriented subject.

- As a result of the focus on the differences within each of the traits NS and HA respectively, the interaction between the two traits is effectively ignored. Cloninger (1987) states that HA and NS are not mutually exclusive, and the relationship between the two traits should therefore be considered, as it might influence responses.

- Finally, own race bias should be taken into account when considering the results as not all the computerised tests were balanced for ethnicity. However, research indicates that basic emotions such as fear, happiness, sadness and anger are "similarly expressed and universally recognised across different social backgrounds and cultures" (Mühlberger et al., 2009, p. 735). Since the focus of this study was on the effect of temperament on emotional processing of facial expressions, it is assumed that own race bias did not have a confounding effect on the results.

5.4 IMPLICATIONS FOR FUTURE STUDIES

According to Van Berkel (2009), several studies have shown that high HA, together with low self-directedness and avoidant coping (both character dimensions on the TCI) have been associated with personality disorders. Cloninger et al. (2006, p. 37) concur, stating that "familial vulnerability to major depression is predicted most strongly by high TCI Harm Avoidance and low TCI Self-Directedness". The authors further argue that high HA and low self-directedness is "predictive of poor response to antidepressants" (Cloninger et al. 2006, p. 37). The present study has found a processing bias for negative emotions in the High HA group, which suggests a conceptual association between high HA, as a possible predisposing factor, and certain psychopathologies such as anxiety and mood disorders. However, multivariate analyses did not corroborate these differences. Hence, future research should examine the influence of both temperament and character on emotional processing, since altered emotional processing and processing biases have been implicated in different psychopathologies such as schizophrenia (Shayegan & Stahl, 2005), posttraumatic stress disorder (Rauch & Foa, 2006), depression (Cloninger et al., 2006), conduct disorder (Stadler et al., 2007) and autism (Kamio et al., 2006).

Deficits in executive functioning, which override pre-potent behavioural and emotional responses and regulate behaviour, have been associated with a breakdown in stress regulation and difficulties with inhibiting inappropriate emotional responses such as aggression (Williams, Suchy & Rau, 2009). Since trait anxiety has been linked to higher stress levels, and impulsivity to aggression, a study examining the relationship between temperament and executive functioning, and its effect on emotional processing, would shed further light on the development and maintenance of psychopathologies.

Finally, the results of the present study indicated that individuals with NS temperament extremes have a more significant emotion processing bias than those with extremes in HA. The High NS group was better at recognising and discriminating between different emotional expressions, which suggested better social interactions (Adams et al., 2006). Future research should examine the effects of temperament on sociability and how it affects social interaction and interpersonal relationships.

5.5 CONCLUSION

The aim of the study was to explore the bias differences within specific temperament traits on emotional processing. The study examined whether individual differences within HA and NS respectively, influenced the processing of emotional expressions.

Contrary to expectations, the High HA group did not respond significantly to all stimuli, nor did they show statistically significant response times when presented with negative emotional stimuli. Multivariate analysis did not confirm a significant difference between the responses of the High HA group and the Low HA group, but this may be as a result of the presentation of a stranger face, which attenuates the processing of the specific valence conveyed in facial emotional expressions (Beaton et al., 2008). Univariate analysis revealed a processing bias for negative emotional expressions in the High HA group. This provides a conceptual association between high HA as a possible predisposing factor in the development and maintenance of psychopathologies. Murphy et al. (2008) concur, stating that mood congruent biases in the processing of emotional stimuli play a role in the maintenance of anxiety disorders.

Multivariate analysis revealed moderately significant differences between the High and Low NS groups for discrimination of happy and sad faces in the Emotion Discrimination Task, and for discerning emotional valence of happy from neutral and sad from neutral facial expressions in the Emotional Acuity Test. In both instances the High NS group performed better than the Low NS group.

The univariate results revealed that high NS was found to be significantly associated with correctly identifying and discriminating between happy, sad and neutral expressions, but not angry or fearful expressions. The High NS group was also able to recognise the spectrum of emotions faster than the Low NS group. Slight changes in an individual's expression is indicative of change of mood, and the ability to pick up on such cues and respond accordingly is essential for effective social interaction. Discrimination of such slight variation in emotional intensity therefore suggests heightened attention to emotional cues during social interaction. The results therefore indicate that the more impulsive and extroverted individuals show an increased ability to process emotional faces.

Recent evidence link differences in personality dimensions to early perceptual processing of faces (Yoshino et al., 2005; Mühlberger et al., 2009). Lohr et al. (2004, p. 1639) state that "emotions drive selective attention to stimuli in the environment and bias information processing both from the surroundings and from memory". Overall, the findings of this study suggest that processing of affective valence varies according to individual differences within specific temperament traits.

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