Facial Emotion Recognition and Processing in

Fearless Dominance and Impulsive Antisociality

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Abstract

Psychopathy has been shown to be associated with deficits in recognizing and processing emotion. We used a face recognition task in which 86 participants screened in the Vanderbilt emergency room viewed faces of men and women expressing one of seven possible emotions and identified which emotion each face displayed. During this task, we recorded the participants’ accuracy in identifying the emotion portrayed by each face and their brains’ responses to the faces through EEG. These responses were correlated with scores on fearless dominance (FD) and impulsive antisociality (IA) in psychopathy. We found that whereas FD was unrelated to facial recognition accuracy, IA was negatively correlated with recognition of disgust, and that those high in IA mistook pictures of disgusted faces as angry. Mirroring these behavioral findings, the amplitudes of the early P1 component for disgust faces were inversely related to IA, particularly for components measured in the right hemisphere. In contrast, the right frontal vertex positive potential was negatively correlated with FD for all faces. P3 magnitude was negatively correlated with all faces, and significantly more negatively correlated with FD for angry faces than for fearful faces; again, these relationships were observed in the right hemisphere. Taken together, these results indicate that both FD and IA are associated with deviant right hemispheric face processing, but these deficits are reflected in behavioral emotion recognition only in IA.

*Keywords:* emotion recognition, psychopathy, event-related potentials

**Introduction**

 Psychopathy is a personality disorder characterized by antisocial deviance in the context of affective and interpersonal detachment. It is a disorder that consists of multiple components ranging on the emotional, interpersonal, and behavioral spectrum (Blair, 2005; Hall, Benning, & Patrick, 2004). H. M. Cleckley’s (1976) treatise *The Mask of Sanity* introduced the idea of the “successful” psychopath even as it provided the initial clinical description of psychopathy. Successful psychopaths are individuals who possess features of psychopathy, but are able to function adaptively in society and avoid negative encounters with law enforcement (Cleckley, 1976). This work led to a heightened interest in hidden psychopaths in society at large, and inspired other psychologists to enter this field of study. However

**Assessing Psychopathy in the Community**

 The Psychopathy Checklist (PCL; Hare, 1980) and the later Revised edition (PCL-R; Hare, 2003) were created to measure psychopathy in incarcerated individuals. These self-report measures were combined with extensive background checks and lengthy personal interviews in order to be fully comprehensive in the measurement of psychopathy. The PCL-R introduced the idea of psychopathy “factors”, which will be discussed later. Some problems exist with this test, however. First, the two factors are correlated by a measure of behavioral deviance, which makes it hard to separate correlational relationships with other aspects of psychopathy (Benning, Patrick, Hicks, Blonigen, & Krueger, 2003). Also, this test is cumbersome, considering the amount of time and information needed to supply a background file and interview.

The Psychopathic Personality Inventory (PPI; Lilienfeld & Andrews, 1996) was designed to measure specific aspects of the psychopathic personality, and also found there to be two distinct factors of psychopathy, but the two factors in this case were not correlated (Ross, Benning, Patrick, Thompson, & Thurston, 2009). Using the PPI as a measure of psychopathy, Benning et al. (2003) revealed two dominant, uncorrelated factors of psychopathy. Recall that a two-factor model of the PCL-R was also proposed, but the two factors were correlated by the common factor of behavioral deviance. The uncorrelated factors of the PPI suggest that psychopathy is not a disorder where the two factors magnify one another in a multiplicative manner, but rather are separate and affect the individual in an additive manner. The first factor (fearless dominance) is associated with “high social potency, narcissistic personality features, and interpersonal features of psychopathy, along with traits of low stress reaction, low harm avoidance, and reduced fears and anxiety” (Benning, Patrick, Blonigen, Hicks, & Iacono, 2005). The second factor (impulsive antisociality) is selectively associated with “traits of alienation and aggression, anger, antisocial behavior and substance abuse, low socialization, and high PCL-R Factor 2 along with impulsivity, low control, and low sociality” (Benning, Patrick, Blonigen, et al., 2005). Fearless dominance appears to be associated with more adaptive demographic and personality features, whereas impulsive antisociality is associated with more maladaptive personality traits and life outcomes (Benning et al., 2003; Benning, Patrick, Salekin, et al., 2005). Though both factors are associated with psychopathy prototype scores (Ross et al., 2009), fearless dominance is preferentially associated with the interpersonal and affective deficits in psychopathy, whereas impulsive antisociality is preferentially associated with the impulsive and antisocial symptoms of psychopathy (Benning, Patrick, Salekin, & Leistico, 2005).

These factors can be predicted well using normal-range personality dimensions (Benning et al., 2003), such as those embodied in the Multidimensional Personality Questionnaire (MPQ). The MPQ is a self-report personality inventory consisting of 11 primary trait scales (Tellegen & Waller, 2008), and it also contains validity scales that enable the detection of biased or inconsistent responses (Hall, Benning, & Patrick, 2004). Because the MPQ and the PPI have validity scales to measure impression management, individuals’ attempts to portray themselves in overly positive ways can be detected, and participants showing excessive positive self-presentation can be excluded.

MPQ-estimated fearless dominance and impulsive antisociality have unique relationships with emotional deficits. Fearless dominance is associated with reduced fear-potentiated startle and reduced skin conductance magnitude to aversive pictures specifically (Benning, Patrick, & Iacono, 2005). Though impulsive antisociality is associated with intact defensive startle reactivity, it is associated with reduced overall skin conductance magnitude to all pictures (Benning, Patrick, & Iacono, 2005), suggesting that it may be associated with chronic somatic underarousal to all emotionally relevant stimuli. However, the psychophysiological emotional reactivity of these two factors has not been explored outside of picture viewing paradigms, raising questions as to the generalizability of these deficits.

**Facial Emotion Processing: ERP Measures and Deficits in Psychopathy**

 **Facial emotion recognition in psychopathy**. Psychopathy is an emotional and social pathology, which makes interpersonal processing a key area of research interest. Facial expressions are particularly potent social stimuli that convey emotional information. Accurately identifying emotions found in facial expressions helps individuals understand the feelings and intentions of others, which plays a major role in interpersonal communication. Some studies have shown that individuals exhibiting antisocial behavior perceive ambiguous social cues as threatening (Crick & Dodge, 1994), whereas others show impairment in recognizing anger and disgust (Best, Williams, & Coccaro, 2002). Individuals with a combination of high levels of externalized antisocial behavior and psychopathic tendencies show the greatest impairments in facial expression recognition when compared to those with only antisocial behavior (Fairchild, Van Goozen, Calder, Stollery, & Goodyer, 2009). A study by Blair, Morris, Frith, Perrett, and Dolan (1999) showed reduced autonomic responses to sad and fearful expressions, which may reflect early amygdala damage. Marsh and Blair (2007) also found that antisocial behavior was negatively correlated with the recognition of fear, sad, and surprised faces, but not happy, anger, or disgust.

**ERP measures of face processing.** However, autonomic and behavioral measures do not capture the time course of deficits in face processing, leaving unclear the point at which psychopathic deficits in recognizing specific facial emotions occur. Event-related potentials are well suited to examine the timing of processes involved in face perception and facial expression analysis. The C1, which peaks approximately 90 ms after stimulus onset, and is maximal at the posterior/occipital electrodes. The polarity of this component is inversely related to the orientation of the stimulus, for example a negative going C1 component would represent a stimulus orientation in the upper-half of the visual field. Pourtois et al. (2004) used face pairings to study modulation of the C1 component amplitude, and found differences to support emotional modulation of the C1. Another component of interest is the P1 component is also involved in early processing of visual stimuli. The P1 peaks around 130 ms after stimulus onset and, like the C1, is usually maximal at the posterior/occipital electrodes. Unlike the C1, however, it is usually maximal in lateral electrodes. A larger P1 amplitude suggests increased attentional processing of visual information (Hillyard, Vogel, & Luck, 1998). The N170 wave has been shown to be a face specific component. This wave peak at about 170 ms in the occipito-temporal electrodes, and is involved in pre-categorical structural encoding to faces (Rossion et al., 2000; Batty & Taylor, 2003). The N170 has also been shown to be unaffected by the emotional expression of the face being encoded (Eimer & Holmes, 2002; Holmes et al., 2003).

The Vertex Positive Potential is preferentially sensitive to configural processing of faces and is maximal around the fronto-central electrodes (Luo et al., 2009). This wave peaks around 200-280 ms, and has been shown to vary with emotion, especially fear. The P3 is a late, positive ERP component that is thought to reflect the cognitive processes allocated to perceiving a target stimulus and determining the appropriate response to be made (Kramer & Spinks, 1991). More specifically, the latency of the P3 provides a measure of the processes underlying stimulus discrimination, while its amplitude reflects the amount of arousal involved (Hansenne, 2000). The Late Positive Potential refers to sustained emotional positivity that remains up to 1000 ms after stimulus onset, after the occurrence of any specific ERP component peaks. Eimer and Holmes (2007) found that participants exhibited sustained emotional positivity throughout 1000 ms of recording at the FZ electrode.

Demaree et al. (2005) completed an extensive literature review covering over forty years of research involving the lateralization of emotion. In this review, there is support for lateralization of emotion in general or individual emotions specifically, as well as no lateralization of emotion at all. In light of this study, there is no pressing evidence to suggest a hypothesis in stance with any one particular view.

**Current Study**

An idea that has not been explored in depth in this field is Cleckley’s (1976) idea of the “successful psychopath”. Another way to view this concept, by way of the two-factor model of psychopathy utilized in the present study, is to broaden the scope from psychopaths diagnosed with the PCL-R to those with extremes in psychopathic personality traits as assessed by the MPQ. Considering the limited generalizability and sample selections of previous studies due to the focus on incarcerated individuals, there is limited information on psychopathic traits in society. This study focused on psychopathic traits in the community, which can lead to studies investigating exactly what types of psychopathy features (if any) predispose an individual to be incarcerated. Based on previous literature, we hypothesized that impulsive antisociality would be correlated negatively with facial emotion recognition accuracy (Best et al., 2002; Crick & Dodge, 1994), particularly for fearful, sad, and surprised faces (Blair et al., 1999; Marsh & Blair, 2007).

Another gap in the current research that this study addressed includes ERP measures of facial emotion processing in psychopathy. Previous studies have shown ERPs to represent various brain processes, including the processing of faces. These correlations can be used, in conjunction with psychopathy data, to determine differences in processing that may lead to the emotional and interpersonal deficits associated with the disorder. We hypothesized that we would find ERP data to match the emotion recognition deficits displayed in previous studies. Specifically, we hypothesized that fearless dominance would be selectively associated with deficits in processing of aversive faces, whereas impulsive antisociality would be associated with reduced processing of all faces.

**Method**

**Participants**

 Participants were recruited from a screening process in the Vanderbilt University Hospital Emergency Room waiting area. During the screening process, the participants completed a basic information questionnaire, as well as the MPQ-155 (Patrick, Curtin, & Tellegen, 2002). Eighty-six individuals who produced valid MPQ profiles were contacted and offered monetary compensation for participating in a four-experiment study, which included the current face recognition task. Participants were oversampled from the top, middle, and bottom 10% of each factor to ensure that extremes and middles of the distributions of psychopathic traits were included in the study. There were two run-orders for the multiple parts, to help offset possible effects of fatigue. In the sample, 70 percent of the participants identified as white, 28 percent as black, 1 percent Native American, and 1 percent Asian. A total of 37 males and 49 females participated, and the mean age was 36 years.

Participants whose MPQ profiles changed substantially between test and retest (i.e., those participants whose scores put them in one of the three extreme groups on a factor at screening and in another group during their laboratory visit) were excluded from data analyses. This procedure left a total of 85 participants for analyses involving fearless dominance and 80 participants for analyses involving impulsive antisociality.

**Psychopathy Assessment**

 Fearless dominance and impulsive antisociality in psychopathy were estimated from the MPQ-155 (Patrick et al., 2002), a brief version of the MPQ for use in large-scale screening efforts. The primary traits scales of Social Potency (+), Stress Reaction (-), and Harm Avoidance (-) were significant predictors of fearless dominance; in contrast, the primary trait scales of Alienation (+), Aggression (+), planful Control (-), Traditionalism (-), and Social Closeness (-) were significant predictors of impulsive antisociality (Benning et al., 2003). These estimated scores have demonstrated substantial criterion-related validity in previous studies. For instance, MPQ-estimated fearless dominance is associated with narcissistic personality features and the interpersonal features of psychopathy; it is also negatively related with fearfulness, anxiety, and other forms of internalizing psychopathology (Benning et al., 2005). Conversely, MPQ-estimated impulsive antisociality is associated with antisocial personality features, substance abuse, anger, and disinhibited personality features along with the impulsive and irresponsible lifestyle features of psychopathy (Benning et al., 2005).

**Experimental Stimuli and Design**

 Participants were seated in a padded recliner at a distance of 100 cm from a 20-inch computer screen positioned directly in front of them. A computer running Neuroscan software (version 4.4) collected physiological data. The sensors were applied at the standard international 10-20 EEG sites. The information was recorded on a SynAmps2 system with an online high-pass filter of .05 Hz and a low-pass filter of 500 Hz at a 2000 Hz sampling rate. Offline, data were rereferenced to linked mastoids, epoched within a window 250 ms before stimulus or response onset to 750 ms after stimulus or response onset, and filtered with a low-pass filter of 30 Hz. A correction was applied to reduce artifact from blinks (Semlitsch, Anderer, Schuster, & Presslich, 1986), and trials exhibiting activity greater than 100 μV either during the baseline or during the epoch of interest were excluded from signal averaging.

 Participants were shown face stimuli taken from the Karolinska Directed Emotional Faces set (KDEF; Lundqvist, Flykt, & Öhman, 1998). A total of 6 actors’ emotional expressions were chosen by two lab members based on the quality of their portrayal of all seven emotions. Each face displayed one of seven possible emotions: fear, anger, disgust, happy, neutral, sad, or surprised. An equal number of male and female faces were used, and each face was oriented looking either straight ahead, forty-five degrees to the left, or forty-five degrees to the right. Emotion, gender, and orientation were all balanced.

 The 21 face combinations for each actor were shown to participants in a series of three blocks. The order in which the participant encountered the blocks was determined by one of six prepared run orders, and the order of faces presented within the blocks was randomized. Each block contained 42 faces, resulting in 126 faces for the entire experiment. Each stimulus was displayed for a random amount of time between 2000 and 3000 ms.

**Procedure**

 Participants were welcomed into the lab by lab members, given a consent form, and asked to carefully read it over. Once informed consent was obtained, the participant was led into the interpersonal testing room of the laboratory and began to fill out a serious of questionnaires, including the MPQ-155. During the questionnaire period, experimenters used gauze pads and microderm-abrasion gel to prepare the participant’s skin for sensor placement. This preparation, along with a conductive gel, was used to reduce impedance between the sensors and skin. After the sensors on the face were placed, experimenters fit the participant with an EEG cap by using the proper measurement techniques. The peripheral sensors and EEG sensors were then prepared through abrasion with a blunt tipped gel applicator. EEG was recorded with Ag-AgCl electrodes with linked mastoid reference from FP1, FPZ, FP2, F7, F3, FZ, F4, F8, T7, C3, CZ, C4, T8, P7, P3, PZ, P4, P8, O1, OZ, and O2 (international 10-20 system). Impedances under 5 kΩ were considered acceptable for this study. After grounding and referencing the sensors, and ensuring the impedances were low enough, the participant took part in an interpersonal study in which he/she delivered a series of talks to two listeners. The data from that study are not reported here.

 Upon completion of the first task, the present study began with the experimenter reading through a set of instructions with the participant to ensure that he/she understood the task. Comprehension was further reinforced by a period of practice trials, during which the experimenter remained in the room for questions. After all questions had been answered, the experimenter left the room, and the participant began the task. The participant was offered short breaks between each of the three blocks, to prevent fatigue. After completing all three blocks, the participant rated their engagement in the task by answering four questions on a Likert scale from one (least engaged) to nine (most engaged).

**Data Analysis**

To analyze the participants’ behavioral responses to the tasks, correlations were run between each of the seven emotions and the two factors of psychopathy. Correlations were also run between misattributions of emotion (e.g., participant answered anger when the correct answer was disgust) and the two factors of psychopathy.

Correlations were run between ERP component amplitudes and the two factors of psychopathy. C1 amplitude to faces was assessed as the peak within the window of 60 to 100 ms after stimulus onset minus the mean activity in the 200 ms prestimulus baseline. P1 amplitude to faces was assessed as the peak of the window of 75 to 150 ms after stimulus onset relative to the baseline. N170 amplitude to faces was assessed as the peak within the window of 125 to 200 ms after stimulus onset relative to the baseline. The VPP amplitude to faces was assessed as the peak within the window of 140 and 250 ms after stimulus onset relative to the baseline. The P3 amplitude to faces was assessed as the peak within the window of 325 to 600 ms after stimulus onset relative to the baseline. The LPP was assessed as the mean of the window from 400 to 750 ms after stimulus onset relative to the baseline. An α level of .05 was used for all comparisons.

**Results**

**Personality and Behavior**

 As displayed in Table 1, there was a significant difference between the two factors and the ability to identify fear, even though both factors correlated with fear at only a trend level. Impulsive antisociality was negatively correlated with accuracy in identifying disgust. To further explore the behavioral data, Table 2 shows the misattributions of disgust as correlated with the two factors of psychopathy; impulsive antisociality was positively correlated with the misattribution of disgust as anger and sadness. Table 3 shows how the misattribution of disgust correlates with the primary trait scales of the MPQ. The misattribution of disgust as anger was negatively correlated with control, while the misattribution of disgust as sadness was positively correlated with aggression.

**ERPs**

 Table 4 shows the C1 component mean peaks, where fearless dominance is positively correlated with C1 to fear faces. This implies that those high in fearless dominance are not attending to the eyes of fearful faces as much as others. Impulsive antisociality, on the other hand, is negatively correlated with C1 to disgust faces and faces overall. This suggests that they attend to the upper half of the visual field more. Figures 2-4 show the windows of the significant waveforms for the C1 correlations. Table 5 shows the P1 component amplitudes. Fearless dominance exhibited reduced P1 processing to anger, disgust, and happy, and these correlations were shown across the occipital electrodes. Impulsive antisociality showed reduced P1 processing to all faces (especially those expressing anger and sadness) in the right hemisphere, as well as surprise across the entire occipital area. Figure 5 shows the window of the significant waveform in overall faces from the P1 correlation.

Table 6 shows the mean peaks for the N170 component. No correlation of this component’s amplitude with any emotion was significant, which supports Eimer and Holmes’s (2002) findings that this component is not modulated by facial emotion. Table 7 shows the VPP component mean peaks. Fearless dominance was negatively correlated with VPP to all emotions, except for sad, and to faces overall. Table 8 shows the P3 component means, with fearless dominance showing reduced P3 levels to all faces. Table 9 shows the LPP component means, and once again fearless dominance was negatively correlated with LPP to most emotions and to faces overall. Figures 6-9 show the windows of these three significant waveforms to all faces.

**Discussion**

 In this study, we examined how fearless dominance and impulsive antisociality were associated with behavioral and ERP deficits in responding to emotional faces. We found that deficits in identification of facial emotion were associated most strongly with impulsive antisociality, in which recognition of fear and disgust were most impaired. Contrary to our hypotheses, fearless dominance was associated with pervasive deficits in later ERP processing of emotional faces, whereas impulsive antisociality was associated predominantly with selective early deficits in face processing.

**Facial Recognition Behavior**

While neither fearless dominance nor impulsive antisociality were correlated with the identification of fear, the difference between the two factors was significant. In other words, the positive correlation between fearless dominance and identifying fear is significantly different from the negative correlation between impulsive antisociality and identifying fear. Thus, it may be the impulsive and antisocial features of psychopathy that have driven previous negative associations between psychopathy and recognition of fearful faces (Blair et al., 1999; Marsh & Blair, 2007).

Impulsive antisociality was shown to be negatively correlated with recognizing disgust. Furthermore, they were significantly more likely to misattribute disgust as anger, which was driven by the control scale on the MPQ. A low score on the control scale would correspond with more impulsive behaviors, which is one of the factors that load onto the impulsive antisociality construct. Disgust is an emotion more often expressed toward inanimate objects (e.g., trash, rancid milk, etc.), whereas anger is more often perceived to be toward persons. The actions of those who exhibit low control are likely to frustrate or disgust individuals with whom they come in contact. They may associate this “directed disgust” with angry responses to impulsive behavior. The misattribution of disgust as sadness was positively correlated with aggression. A high score on the aggression scale would correspond with an increased propensity to fight or challenge, which is another one of the factors that load onto the impulsive antisociality construct.

**ERPs during Emotional Faces and Psychopathy**

 Both impulsive antisociality and fearless dominance are implicated in the early ERP components of this study. The C1 data suggest that those high in impulsive antisociality are more likely to attend to the eyes of disgust faces and faces overall, which may play into the misattribution of disgust as anger in a similar manner as described above. Those who are high in impulsive antisociality may associate the “directed disgust” with angry responses to their impulsive behaviors, as both emotions feature contractions of the *orbicularis oculi* muscle. The C1 data also suggests that those high in fearless dominance are less likely to attend to the eyes of fear and surprise faces, though this deficit does not give rise to behavioral deficits in recognizing either of these emotions.

 In contrast, impulsive antisociality is negatively correlated with P1 amplitude to faces overall, with negative correlations many of the emotions, as well as overall faces. Since P1 is associated with increased attentional processing of visual information, these findings suggest that those high in impulsive antisociality have decreased attention to faces, and in turn their displayed emotion. Fearless dominance is associated with more selective deficits in P1 amplitude, showing significant amplitude reduction to anger, disgust, and happy faces.

 Fearless dominance showed prevalent reductions in later ERP components: The VPP, P3, and LPP are all negatively correlated with responses to faces by fearless dominance, particularly in the right hemisphere. This implies that those high in fearless dominance process facial configurations less strongly than those who are low in fearless dominance. In turn, they are processing the emotions displayed by those configurations in the same manner. Once again, this EEG evidence does not correlate with any emotion recognition deficits for fearless dominance in this study. Thus, this reduction may represent a more efficient emotion-processing system for those high in fearless dominance. Arguing against this interpretation is that facial emotion recognition is not significantly *better* for those high in fearless dominance. The difference may be accounted for in another area of interpersonal emotion recognition, however, such as empathy. The low arousal, shown by the shallow P3 of high fearless dominance, may lead to low empathetic concern for others.

 Throughout the study, the differences in ERPs to emotional faces between the two groups of psychopathy have been largely right-lateralized. The most striking lateralization in this study occurred for the later ERPs (i.e., VPP, P3, and LPP) at the frontal sensors for fearless dominance, particularly at F8. One of the models explored in the Demaree et al. (2005) study, which seems to have been replicated here, is the right hemisphere model, in which scalp-recorded ERP studies had yielded greater right- versus left-hemisphere activity during the processing of facial affect.

**Limitations and Future Directions**

 Although the results seem to provide an interesting story in regards to the ERP differences of fearless dominance and impulsive antisociality, there were not enough trials available to break down these findings by gender and face orientation. This could prove useful in further explaining the current findings, because gaze direction is a part of interpersonal communication and may play a role in how participants perceive a face’s emotion.

 More research with emotion and psychopathy can be done using media different from static pictures as well. Emotion and interpersonal communication are very complex constructs, and the deficiencies in psychopathy extend far beyond recognizing emotion in pictures of faces. Studies might try using videos of emotionally salient situations and asking participants questions about the scenarios. A study could also video tape interviews of participants and attempt to objectively analyze their interpersonal communication styles.

 The results of this experiment have significant implications for the field of psychopathy and emotion recognition. ERP data in this area of psychopathy is lacking, and this study provides an initial investigation of brain and behavioral processing of facial emotion in fearless dominance and impulsive antisociality. These results add to the body of evidence suggesting that fearless dominance is associated with reduced emotional reactivity in the context of normal behavioral patterns, whereas impulsive antisociality is related to behavior deficits that may be related to more circumscribed emotional processing difficulties.

**References**

Adolph, R., Tranel, D., Damasio, H., & Damasio, A. R. (1995). Fear and the human amygdala [Electronic Version]. *Journal of Neuroscience 15*, 5879-5891.

Adolphs, R. (2002). Neural systems for recognizing emotion [Electronic Version]. *Current Opinion in Neurobiology 12*, 169-177.

Adolphs, R. (2002). Recognizing emotion from facial expressions: Psychological and neurological mechanisms [Electronic Version]. *Behavioral and Cognitive Neuroscience Reviews 1*, 21-62.

Batty, M., & Taylor, M. J. (2003). Early processing of the six basic facial emotion expressions [Electronic Version]. *Cognitive Brain Research 17,* 613-620.

Benning, S. D., Patrick, C. J., & Iacono, W. G. (2005). Psychopathy, startle blink modulation, and electrodermal reactivity in twin men [Electronic Version]. *Psychophysiology 42*, 753-762.

Benning, S. D., Patrick, C. J., Salekin, R. T., & Leistico, A. R. (2005). Convergent and Discriminant Validity of Psychopathy Factors Assessed Via Self-Report: A Comparison of Three Instruments [Electronic Version]. *Assessment 12*, 270-289.

Benning, S. D., Patrick, C. J., Blonigen, D. M., Hicks, B. M., & Iacono, W. G. (2005). Estimating Facets of Psychopathy From Normal Personality Traits: A Step Toward Community Epidemiological Investigations [Electronic Version]. *Assessment 12,* 3-18.

Benning, S. D., Patrick, C. D., Hicks, B. M., Blonigen, D. M., & Kreuger, R. F. (2003). Factor Structure of the Psychopathic Personality Inventory: Validity and Implications for Clinical Assessment [Electronic Version]. *Psychological Assessment 15,* 340-350.

Best, M., Williams, J., & Coccaro, E. (2002). Evidence for a dysfunctional prefrontal circuit in patients with an impulsive aggressive disorder [Electronic Version]. *National Academy of Sciences USA 99*, 8448-8452.

Blair, J. (2005). *The Psychopath: Emotion and The Brain*. Malden: Blackwell Publications.

Blair, R. J. R., & Cipolotti, L. (2000). Impaired social response reversal. A case of 'acquired sociopathy' [Electronic Version]. *Brain: A Journal of Neurology 123,* 1122-1141.

Blair, R. J. R., Morris, J. S., Frith, C. C., Perrett, D. I., & Dolan, R. J. (1999). Dissociable neural responses to facial expressions of sadness and anger [Electronic Version]. *Brain: A Journal of Neurology 122*, 883-893.

Bornhofen, C., & McDonald, S. (2008). Emotion perception deficits following traumatic brain injury: A review of the evidence and rationale for intervention [Electronic Version]. *Journal of the International Neuropsychological Society 14,* 511-525.

Cleckley, H. M. (1976). *The Mask of Sanity*. 5th Edition. St. Louis: Mosby.

Crick, N., & Dodge, K. (1994). A review and reformulation of socail information-processing mechanisms in children's social adjustment [Electronic Version]. *Psychological Bulletin 115*, 74-101.

Demaree, H., Everhart, D. E., Youngstrom, E. A., & Harrison, D. W. (2005). Brain lateralization of emotional processing: Historical roots and a future incorporating 'dominance' [Electronic Version]. *Behavioral and Cognitive Neuroscience Reviews 4*, 3-20.

Eimer, M., & Holmes, A. (2002). An ERP study on the time course of emotional face processing [Electronic Version]. *Neuroreport 13,* 427-431.

Eimer, M., Holmes, A., & McGlone, F. (2003). The role of spatial attention in processing facial expression: An ERP study of rapid brain responses to six basic emotions [Electronic Version]. *Cognitive, Affective, and Behavioral Neuroscience 3,* 97-110.

Eimer, M., & Holmes, A. (2007). Event-related brain potential correlates of emotional face processing [Electronic Version]. *Neuropsychologia 45*, 15-31.

Fairchild, G., Van Goozen, S. H. M., Calder, A. J., Stollery, S. J., & Goodyer, I. M. (2009). Deficits in facial expression recognition in male adolescents with early-onset or adolescenceonset conduct disorder [Electronic Version]. *Journal of Child Psychology and Psychiatry 50,* 627-636.

Hall, J., Benning, S., and Patrick, J. (2004). Criterion-related validity of the three-factor model of psychopathy: personality, behavior, and adaptive functioning [Electronic Version]. *Assessment* *11,* 4-16.

Hansenne, M. (2000). The P300 event-related potential. I. Theoretical and psychobiological perspectives [Electronic Version]. *Neurophysiologie Clinique/Clinical Neurophysiology 30,* 191-210.

Hare, R. D. (1980). A research scale for the assessment of psychopathy in criminal populations [Electronic Version]. *Personality and Individual Differences 1*, 111-119.

Hare, R. D. (2003). *The Hare Psychopathy Checklist-Revised*. Toronto: Multi-Health Systems.

Haxby, J., Hoffman, E. A., & Gobbini, M. I. (2002). Human neural systems for face recognition and social communication [Electronic Version]. *Biological Psychiatry 51*, 59-67.

Hillyard, S., Vogel, E., & Luck, S. (1994). Sensory gain control (amplification) as a mechanism of selective attention: Electrophysiological and neuroimaging evidence [Electronic Version]. *Brain Topography 7*, 41-51.

Hitchcock, J., & Davis, M. (1986). Lesions of the amygdala, but not of the cerebellum or red nucleus, block conditionsed fear as measured with the potentiated startle paradigm [Electronic Version]. *Behavioral Neuroscience 100*, 11-22.

Holmes, A., Vuilleumier, P., & Eimer, M. (2003). The processing of emotional facial expression is gated by spatial attention: Evidence from event-related brain potentials [Electronic Version]. *Cognitive Brain Research* *16*, 174-184.

Hooker, C. & Park, S. (2002). Motion processing and its relationship to social functioning in schizophrenia patients [Electronic Version]. *Psychiatry Research 112,* 41-50.

Kramer, A. & Spinks, J. (1991). Capacity views of human information processing. In Jennings, J. R., Coles, M. G. H (Eds.), *Handbook of cognitive psychophysiology: Central and autonomic nervous system approaches* (pp. 179-242). New York: John Wiley & Sons.

Krueger, R., Markon, K. E., Patrick, C. J., Benning, S. D., & Kramer, M. D. (2007). Linking antisocial behavior, substance use, and personality: An integrative quantitative model of the adult externalizing spectrum [Electronic Version]. *Journal of Abnormal Psychology 116*, 645-666.

Luo, W., Feng, W., He, W., Wang, N., & Luo, Y.. (2009). Three stages of facial expression processing: ERP study with rapid serial visual presentation [Electronic Version]. *Neuroimage 49*, 1857-1867.

Lundqvist, D., Flykt, A., & Öhman, A. (1998). The Karolinska Directed Emotional Faces - KDEF, CD ROM from Department of Clinical Neuroscience, Psychology section, Karolinska Institute, ISBN 91-630-7164-9.

Marsh, A. A., & Blair, R. J. R. (2007). Deficits in facial affect recognition among antisocial populations: A meta-analysis [Electronic Version]. *Neuroscience and Biobehavioral Reviews 32,* 454-465.

Mueser, K., Doonan, R., Penn, D. L., Blanchard, J. J., Bellack, A. S., Nishith, P., & DeLeon, J. (1996). Emotion recognition and social competence in chronic schizophrenia [Electronic Version]. *Journal of Abnormal Psychology 105*, 271-275.

Muños, L. (2009). Callous-unemotional traits are related to combined deficits in recognizing afraid faces and body poses [Electronic Version]. *Journal of the American Academy of Child & Adolescent Psychiatry 48*, 554-562.

Partick, C., Edens, J. F., Poythress, N. G., Lilienfeld, S. O., & Benning, S. D. (2006). Construct validity of the Psychopathic Personality Inventory two-factor model with offenders [Electronic Version]. *Psychological Assessment 18*, 204-208.

Patrick, C. (1994). Emotion and psychopathy: startling new insights [Electronic Version]. *Psychophysiology 31*, 319-330.

Pourtois, G., Grandjean, P., Sander, A., & Vuilleumier, P. (2004). Electrophysiological correlates of rapid spatial orienting towards fearful faces [Electronic Version]. *Cerebral Cortex 14,* 619-633.

Raine, A., Yang, Y., Narr, K. L., Colletti, P., & Toga, A. W. (2009). Localization of deformations within the amygdala in individuals with psychopathy [Electronic Version]. *Archives of General Psychiatry 66,* 986-994.

Ross, S., Benning, S. D., Patrick, C. J., Thompson, A., & Thurston, A. (2009). Factors of the Psychopathic Personality Inventory: Criterion-related validity and relationship to the BIS/BAS and Five-Factor Models of Personality [Electronic Version]. *Assessment* *16*, 71-87.

Ross, S., Benning, S., & Adams, Z. (2007). Symptoms of executive dysfunction are endemic to secondary psychopathy: An examination in criminal offenders and noninstitutionalized young adults [Electronic Version]. *Journal of Personality Disorders* *21*, 384-399.

Rossion, B., Gauthier, I., Tarr, M. J., Despland, P., Bruyer, R., Linotte, S., & Crommelinck, M. (2000). The N170 occipito-temporal component is delayed and enhanced to inverted faces but not to inverted objects: an electrophysiological account of face-specific processes in the human brain [Electronic Version]. *NeuroReport* *11*, 69-74.

Tellegen, A., & Waller, N. G. (2008). Exploring personality through test construction: Development of the multidimensional personality questionnaire. In Boyle, G. J., Matthews, G., & Saklofske, D. H. (Eds.), *The SAGE handbook of personality theory and assessment* (Vol 2 pp. 261-292). Thousand Oaks, CA: Sage Publications, Inc.

Witt, E., Donnellan, M. B., Blonigen, D. M., Krueger, R. F., & Conger, R. D. (2009). Assessment of fearless dominance and impulsive antisociality via normal personality measures: Convergent validity, criterion validity, and developmental change [Electronic Version]. *Journal of Personality Assessment* *91*, 265-276.

Table 1

*Correlations between Psychopathy Factors and Emotion Identification Accuracy*

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  |  |
| **Emotion** |  | **FD** | **IA** |
|  |  |  |  |
| Fear\* |  | .195 | -.211 |
|  |  |  |
|  |  |  |  |
| Anger |  | .010 | -.063 |
|  |  |  |
|  |  |  |  |
| Disgust |  | -.061 | -.283\* |
|  |  |  |
|  |  |  |  |
| Happy |  | .119 | -.050 |
|  |  |  |
|  |  |  |  |
| Neutral |  | .113 | -.121 |
|  |  |  |
|  |  |  |  |
| Sad |  | .153 | .071 |
|  |  |  |
|  |  |  |  |
| Surprise |  | -.040 | -.003 |
|  |  |  |
|  |  |  |  |
| All Faces |  | .109 | -.154 |
|  |  |  |

*Note.* \* *p* < 0.05. An asterisk by a variable name represents a significant difference between the two factors’ association with that variable. FD = Fearless Dominance, IA = Impulsive Antisociality. *n* = 85 for FD, *n* = 80 for IA.

Table 2

*Correlations between Psychopathy Factors and Misattribution of Disgust as Another Emotion*

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|

|  |  |  |
| --- | --- | --- |
| **Misattribution** | **FD** | **IA** |
| Fear | .124 | .079 |
| Anger | -.040 | .232\* |
| Happy | -.099 | -.028 |
| Neutral | -.047 | -.013 |
| Sad | .243\* | .300\* |
| Surprise | -.096 | -.032 |

 |  |  |

*Note.* \* *p* < 0.05. FD = Fearless Dominance, IA = Impulsive Antisociality. *n* = 85 for FD, *n* = 80 for IA.

Table 3

*Correlations between MPQ Primary Trait Scales and Misattribution of Disgust as Anger*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Well-Being** | **Social Potency** | **Achievement** | **Social Closeness** | **Stress Reaction** |  |
| Anger |  -.072 |  -.026 | .005 |  -.162 | .207 |  |
| Sad |  .080 |  .130 |  -.051 |  .013 |  |  -.211 |
|  |  |  |  |  |  |  |
|  | **Alienation** | **Aggression** |  **Control** | **Harm Avoidance** | **Traditionalism** | **Absorption** |
| Anger |  .181 |  .122 |  -.236\* |  -.180 |  .153 |  .178 |
| Sad |  .015 |  .350\*\* |  -.139 |  -.123 |  -.173 |  -.066 |

*Note.* \* *p* < 0.05; \*\* *p* < 0.01. FD = Fearless Dominance, IA = Impulsive Antisociality. *n* = 85.

Table 4

*Correlations between Psychopathy Factors and C1 Amplitude by Emotion*

|  |  |  |  |
| --- | --- | --- | --- |
|  |  **O1** |  **OZ** |  **O2** |
| **Emotion** | **FD** | **IA** | **FD** | **IA** | **FD** | **IA** |
| Fear | .277\* | -.030 | .201 | .054 | .295\*\* | -.029 |
| Anger | -.035 | -.105 | -.019 | .077 | -.015 | -.141 |
| Disgust | -.050 | -.117 | -.017 | .019 | .002 | -.238\* |
| Happy | -.013 | -.060 | -.047 | -.069 | -.037 | -.124 |
| Neutral | -.028 | -.052 | -.058 | .014 | -.032 | -.170 |
| Sad | .105 | -.023 | .108 | .102 | .095 | -.216 |
| Surprise | .158 | -.144 | .232\* | -.221 | .078 | -.041 |
| All Faces | .090 | -.087 | .148 | .023 | .189 | -.227\* |

*Note.* \* *p* < 0.05; \*\* *p* < 0.01. FD = Fearless Dominance, IA = Impulsive Antisociality. Due to different numbers of excluded subjects based on excessive noise for different emotions, *n* ranges from 77-83 for FD, *n* ranges from 72-78 for IA.

Table 5

*Correlations between Psychopathy Factors and P1 Amplitude by Emotion*

|  |  |  |  |
| --- | --- | --- | --- |
|  |  **O1** |  **OZ** |  **O2** |
| **Emotion** | **FD** | **IA** | **FD** | **IA** | **FD** | **IA** |
| Fear | .017 | .033 | -.013 | .038 | .054 | -.104 |
| Anger | -.269\* | -.178 | -.250\* | -.172 | -.143 | -.278\* |
| Disgust | -.246\* | -.230\* | -.239\* | -.146 | -.228\* | -.230 |
| Happy | -.239\* | -.135 | -.214 | -.204 | -.202 | -.182 |
| Neutral | -.167 | -.081 | -.090 | -.044 | -.111 | -.169 |
| Sad | -.064 | -.070 | -.123 | .015 | -.017 | -.259\* |
| Surprise | -.019 | -.297\* | .021 | -.282\* | -.089 | -.234\* |
| All Faces | -.117 | -.104 | -.088 | -.068 | .020 | -.247\* |

*Note.* \* *p* < 0.05. FD = Fearless Dominance, IA = Impulsive Antisociality. Due to different numbers of excluded subjects based on excessive noise for different emotions, *n* ranges from 77-83 for FD, *n* ranges from 72-78 for IA.

Table 6

*Correlations between Psychopathy Factors and N170 Amplitude by Emotion*

|  |  |  |  |
| --- | --- | --- | --- |
|  |  **P7** |  **PZ** |  **P8** |
| **Emotion** | **FD** | **IA** | **FD** | **IA** | **FD** | **IA** |
| Fear | .037 | .103 | -.036 | .118 | .117 | .182 |
| Anger | -.079 | -.129 | -.059 | .138 | .012 | .054 |
| Disgust | -.075 | -.058 | -.136 | .191 | .049 | .141 |
| Happy | -.061 | .026 | -.030 | .061 | .034 | .146 |
| Neutral | .058 | .080 | -.023 | .211 | .048 | .121 |
| Sad | -.043 | -.056 | -.071 | .210 | .088 | .211 |
| Surprise | .110 | -.034 | .034 | .201 | .081 | .168 |
| All Faces | .051 | .001 | -.071 | .204 | .042 | .170 |

*Note.* \* *p* < 0.05. FD = Fearless Dominance, IA = Impulsive Antisociality. Due to different numbers of excluded subjects based on excessive noise for different emotions, *n* ranges from 77-83 for FD, *n* ranges from 72-78 for IA

Table 7

*Correlations between Psychopathy Factors and VPP Amplitude by Emotion*

|  |  |  |  |
| --- | --- | --- | --- |
|  |  **F7** |  **FZ** |  **F8** |
| **Emotion** | **FD** | **IA** | **FD** | **IA** | **FD** | **IA** |
| Fear | -.029 | -.219 | -.109 | -.028 | -.249\* | .186 |
| Anger | -.125 | -.110 | -.252\* | -.203 | -.273\* | .096 |
| Disgust | -.129 | -.012 | -.200 | .100 | -.315\*\* | .184 |
| Happy | -.153 | -.066 | -.170 | .029 | -.290\*\* | .153 |
| Neutral | .065 | -.221 | -.074 | -.067 | -.256\* | .160 |
| Sad | -.172 | -.118 | -.289\*\* | .114 | -.208 | .092 |
| Surprise | -.096 | -.218 | -.171 | -.014 | -.295\*\* | .114 |
| All Faces | -.062 | -.178 | -.168 | -.040 | -.337\*\* | .162 |

*Note.* \* *p* < 0.05; \*\* *p* < 0.01. FD = Fearless Dominance, IA = Impulsive Antisociality. Due to different numbers of excluded subjects based on excessive noise for different emotions, *n* ranges from 83-84 for FD, *n* ranges from 78-79 for IA.

Table 8

*Correlations between Psychopathy Factors and P3 Amplitude by Emotion*

|  |  |  |  |
| --- | --- | --- | --- |
|  |  **F7** |  **FZ** |  **F8** |
| **Emotion** | **FD** | **IA** | **FD** | **IA** | **FD** | **IA** |
| Fear | -.030 | -.077 | -.110 | -.011 | -.341\*\* | .088 |
| Anger | -.006 | -.012 | -.188 | -.034 | -.288\* | .068 |
| Disgust | -.056 | -.093 | -.204 | .011 | -.363\*\* | .016 |
| Happy | -.071 | -.113 | -.151 | -.165 | -.329\*\* | .108 |
| Neutral | -.013 | -.099 | -.122 | -.097 | -.295\*\* | .022 |
| Sad | .013 | -.085 | -.123 | -.019 | -.225 | .036 |
| Surprise | .036 | -.111 | -.107 | -.104 | -.228\* | .005 |
| All Faces | .002 | -.083 | -.136 | -.063 | -.352\*\* | .077 |

*Note.* \* *p* < 0.05; \*\* *p* < 0.01. FD = Fearless Dominance, IA = Impulsive Antisociality. Due to different numbers of excluded subjects based on excessive noise for different emotions, *n* ranges from 73-83 for FD, *n* ranges from 70-78 for IA.

Table 9

*Correlations between Psychopathy Factors and LPP Amplitude by Emotion*

|  |  |  |  |
| --- | --- | --- | --- |
|  |  **F7** |  **FZ** |  **F8** |
| **Emotion** | **FD** | **IA** | **FD** | **IA** | **FD** | **IA** |
| Fear | .018 | -.099 | -.028 | -.019 | -.286\* | .082 |
| Anger | .025 | -.035 | -.125 | -.067 | -.239\* | .015 |
| Disgust | -.007 | -.067 | -.143 | -.013 | -.297\*\* | -.056 |
| Happy | -.039 | -.107 | -.102 | -.180 | -.270\* | .034 |
| Neutral | .018 | -.049 | -.045 | -.090 | -.224 | .043 |
| Sad | .048 | -.096 | -.070 | -.080 | -.191 | -.015 |
| Surprise | .093 | -.096 | -.048 | -.115 | -.179 | -.038 |
| All Faces | .013 | -.073 | -.094 | -.077 | -.315\*\* | .058 |

*Note.* \* *p* < 0.05; \*\* *p* < 0.01. FD = Fearless Dominance, IA = Impulsive Antisociality. Due to different numbers of excluded subjects based on excessive noise for different emotions, *n* ranges from 74-83 for FD, *n* ranges from 70-78 for IA..



Time (ms)

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*Figure 1*. Grand average stimulus-locked ERPs to all faces



O1

OZ

O2\*

*Figure 2*. Grand average stimulus-locked ERPs to all faces – C1 at O1, OZ, O2

Microvolts

Time (ms)

*Figure 3*. Grand average stimulus-locked ERPs to fearful faces – C1 at O1, OZ, O2

O1\*

OZ

O2\*\*

Microvolts



Time (ms)



O1

OZ

O2\*

*Figure 4*. Grand average stimulus-locked ERPs to disgusted faces – C1 at O1, OZ, O2

Microvolts

Time (ms)

O1

OZ

O2\*

*Figure 5*. Grand average stimulus-locked ERPs to all faces – P1 at O1, OZ, O2

Microvolts

Time (ms)



F7

FZ

F8\*

*Figure 6*. Grand average stimulus-locked ERPs to all faces – VPP at F7, FZ, F8

Microvolts



Time (ms)

F7

FZ

F8\*

*Figure 7*. Grand average stimulus-locked ERPs to all faces – P3 at F7, FZ, F8

Microvolts



F7

FZ

F8\*

*Figure 8*. Grand average stimulus-locked ERPs to all faces – LPP at F7, FZ, F8

Microvolts

Time (ms)

