Accepted Manuscript

Title: The Mediating Role of Emotional Intelligence on the Autonomic Functioning – Psychopathy Relationship

Authors: Shichun Ling, Adrian Raine, Yu Gao, Robert Schug

PII: S0301-0511(18)30398-3
DOI: https://doi.org/10.1016/j.biopsycho.2018.05.012
Reference: BIOPSY 7540

To appear in:

Received date: 18-7-2017
Revised date: 23-3-2018
Accepted date: 17-5-2018

The Mediating Role of Emotional Intelligence on the Autonomic Functioning – Psychopathy Relationship

Shichun Ling[a*], Adrian Raine[b], Yu Gao[c], and Robert Schug[d]

[a] Department of Criminology
University of Pennsylvania
3718 Locust Walk, Suite 483
Philadelphia, PA, USA 19104
lings@sas.upenn.edu

[b] Departments of Criminology, Psychiatry, and Psychology
University of Pennsylvania
3809 Walnut Street, Suite 204
Philadelphia, PA, USA 19104
araine@sas.upenn.edu

[c] Department of Psychology
City University of New York – Brooklyn College
5602C James Hall
Brooklyn, NY, USA 11210
yugao@brooklyn.cuny.edu

[d] School of Criminology, Criminal Justice, and Emergency Management
California State University – Long Beach
1250 Bellflower Blvd, Engineering Technology 250
Long Beach, CA, USA
Robert.Schug@csulb.edu

*Corresponding author

Highlights

- Emotional intelligence fully mediates the ANS functioning-psychopathy relationship.
- Full mediation effects were found at all psychopathy factor and most facet levels.
- Partial mediation was found for the heart rate – antisocial (Facet 4) relationship.
- Mediation effects of emotional intelligence were independent of IQ.

Abstract

Reduced autonomic activity is a risk factor for psychopathy, but the mechanisms underlying this association are under-researched. We hypothesize that emotional intelligence mediates this relationship. Emotional intelligence, cognitive intelligence, scores on the Psychopathy Checklist-Revised (PCL-R), skin conductance, and heart rate were assessed in 156 men from communities in Los Angeles. Emotional intelligence fully mediated the relationship between autonomic functioning and total psychopathy after controlling for cognitive intelligence for both autonomic measures. Full mediation was also found when using PCL-R factors and facets as outcome variables, with the exception of a partial mediation of the heart rate –Antisocial facet relationship. These findings are the first to document emotional intelligence as a mediator of the blunted physiological stress activity – psychopathy relationship, and are interpreted within the framework of the somatic marker and somatic aphasia theories of psychopathy. Possible implications for treatment interventions are also discussed.

Keywords: skin conductance, heart rate, autonomic functioning, emotional intelligence, psychopathy, mediation

Introduction

Psychopathy is characterized by interpersonal and affective impairments accompanied by deviance or a disregard of societal rules (Hare & Neumann, 2010a). Previous research suggests that blunted autonomic functioning is one of the best-replicated correlates of psychopathy (Marsh, 2013; Patrick, 2006). In particular, psychopaths exhibit lower levels of skin conductance (a measure of sympathetic nervous system activity) when anticipating punishment and lower conditioning to aversive stimuli (Hare, 1965). Reduced heart rate (a measure of both sympathetic and parasympathetic nervous system activity) during both rest and stress has also been documented in antisocial individuals (Ortiz & Raine, 2004), including psychopaths (Gao, Raine, & Schug, 2012). Longitudinal studies suggest that low heart rate predisposes to subsequent aggression, psychopathy, and violence (Baker et al., 2009; Portnoy & Farrington, 2015). This hypo-activation during stress may reflect an underlying impairment in autonomic functioning. However, few studies have investigated mechanisms explaining how blunted autonomic (autonomic nervous system - ANS) activity might predispose to psychopathic traits.

Emotional dysfunction in psychopathic individuals is well-documented. Psychopathic individuals tend to exhibit lower physiological reactions to distressing visual stimuli (Patrick, Cuthbert, & Lang, 1994) and emotional sounds (Verona, Patrick, Curtin, Bradley, & Lang, 2004) as well as reduced modulation of startle responses to emotional stimuli (Patrick, Bradley, & Lang, 1993). Deficits in emotion recognition in facial expressions (Blair et al., 2004) and speech (Blair et al., 2002) have also been documented in psychopathic individuals. These deficits are found not only to distress cues such as fear and sadness (Blair, Jones, Clark, & Smith, 1997; Marsh & Blair, 2008; Wilson, Juodis, & Porter, 2011), but rather are a pervasive deficit for facial and vocal expressions of affect in psychopathy (Dawel, O'Kearney, McKone, & Palermo, 2012). These disturbances in recognition and responsivity to emotional stimuli are considered characteristic of psychopathy.

Although psychopaths are partly characterized by affective deficits, there is debate about whether psychopaths have a deficit in emotional intelligence (i.e., an individual's ability to monitor and label emotions within oneself and others, and to use emotion to guide behavior and decision-making; Coleman, 2015). Ermer, Kahn, Salovey, and Kiehl found no relationship between overall EI and psychopathy in incarcerated men, but did find an inverse relationship once cognitive intelligence was controlled for (Ermer, Kahn, Salovey, & Kiehl, 2012). Contrary to these findings, Copestake, Gray, and Snowden (2013) found that psychopathy was related to heightened EI even after controlling for cognitive intelligence in a sample of offenders. In college students, EI was inversely related to psychopathy (Fix & Fix, 2015; Watts et al., 2016). Thus the relationship between EI and psychopathy has been inconsistent.

The somatic marker hypothesis (Damasio, 1994) provides a theoretical framework to explain how blunted autonomic functioning can impair emotional states and lead to subsequent inappropriate and antisocial behavior. It argues that appropriate autonomic functioning is critical to experiencing emotional states that guide good decision-making; emotions associated with previous experiences provide somatic markers, unpleasant gut feelings, that function as alarm signals alerting the individual to the potential negative outcome of a given action (Damasio, 1994). These markers include both visceral and non-visceral sensations in response to external stimuli, and are associated with both positive and negative emotional states. The inability to experience and interpret this "gut feeling" has been argued to predispose individuals to psychopathic and antisocial behavior by impairing emotional decision-making processes (Bechara, Damasio, & Damasio, 2000). As such, we hypothesize that biological dysfunction (reduced autonomic functioning) may be associated with a learned social-emotional skill (emotional intelligence) which in turn can be associated with psychopathic traits.

In this study, we aim to test whether: (1) EI mediates the autonomic functioning – psychopathic traits relationship, (2) EI mediational effects are found for all features of psychopathy, and (3) these effects are independent of IQ. We hypothesize that impairments in autonomic functioning during a stressor predisposes to low EI, which in turn predisposes an individual to psychopathy.

Materials and Methods

Subjects

Participants consisted of 156 males recruited from five temporary employment agencies in the greater Los Angeles area. The mean age was 35.72 years (*SD* = 8.61, range = 21 – 66 years). Ethnicity was as follows: 44.2% Black, 32.7% Caucasian, 16% Hispanic, 3.2% Asian, and 3.8% other. Previous research has suggested that individuals seeking jobs through temporary employment agencies are at high socioeconomic risk, with an eight-fold increase in the yield of those with psychopathy/antisocial personality (Raine, Yang, Narr, & Toga, 2011). The exclusion criteria included: age younger than 18 years, non-fluency in English, history of epilepsy or claustrophobia, ostensible neurological abnormality, use of a pacemaker, and metal implants. The order of the tests was the same for every participant, with questionnaires being completed before the psychophysiological testing. Prior to beginning data collection, the principal investigator obtained a certificate of confidentiality from the Secretary of Health pursuant to Section 303(a) of Public Health Act 42. Participants were assured that any information they might provide about uninvestigated crimes could not be subpoenaed by any United States federal, state, or local court.

The study and all its procedures were approved by the Institutional Review Boards at the University of Southern California and the University of Pennsylvania.

Measures

Autonomic Stress Functioning. Skin conductance and heart rate were measured during a social stressor task designed to elicit secondary emotions such as embarrassment and guilt (Damasio, 2000). Subjects were given two minutes to prepare a speech about the worst thing they had ever done (preparation period), followed by a two-minute period in which they gave their speech to the experimenter while being videotaped (presentation period). If the participant had difficulty speaking continuously, the research assistant requested him to give specific examples of the reported fault(s) to enhance the stressful nature of the task (Raine, Lencz, Bihrle, LaCasse, & Colletti, 2000). Only autonomic stress activation from the two-minute preparation period was analyzed in this study as the speech presentation period is more susceptible to movement, speech, and respiratory artifacts on electrodermal and cardiovascular measures (Beda et al., 2007; Boucsein, 2012; Choy et al., 2015). The skin conductance measure reflects the averaged skin conductance over the two-minute preparation period, while the heart rate measure reflects the averaged heart rate over the two-minute preparation period.

Participants were tested in a temperature-controlled, light- and sound-attenuated room. All psychophysiological data were collected with equipment and software from the James Long Company (1999; Caroga Lake, New York). An isolated bioelectric amplifier was used and physiological data were recorded online directly into a data acquisition computer. To measure heart rate, the channel of the grounded electrocardiograph was recorded through disposable electrodes that were attached to either side of the participant's lowest ribs to reduce movement artifacts. Heart rate data were analyzed using the Interbeat Interval Analysis Software program

(James Long Company). R-waves were sampled every 0.1 seconds. Skin conductance activity was recorded from bipolar leads on the distal phalanges of the index and middle fingers of the non-dominant hand (Scerbo, Freedman, Raine, Dawson, & Venables, 1992) using silver–silver chloride electrodes (0.8 cm in diameter). The conducting medium was K–Y lubricating jelly, surrounded by an adhesive electrode collar to delineate consistent contact area of the conducting medium with the skin. Skin conductance level was recorded using a low-pass filter set to 10 Hz. The signal was digitized at a sampling rate of 512 Hz, with 12 bits of resolution (corresponding to a step size of < .01 μS).

Cognitive Intelligence. An estimate of cognitive intelligence was obtained using the WAIS-III (Wechsler, 1997). Participants were administered four WAIS-III subtests, each representing one of the four component indices of the Full Scale IQ (FSIQ): Similarities representing the Verbal Comprehension Index (VCI), Arithmetic representing the Working Memory Index (WMI), Picture Completion representing the Perceptual Organization Index (POI), and Digit-Symbol Coding representing the Processing Speed Index (PSI). Subtest scores were individually multiplied by the number of subtests comprising the corresponding index (e.g., the VCI is comprised of four subtests; thus, the Similarities subtest score was multiplied by four to estimate the VCI). The resulting four "prorated" index scores were then summed to estimate FSIQ. This method of estimating IQ has been used in previous studies (Gao, Raine & Schug, 2011; Gao, Raine, & Schug, 2012). All mediation analyses of EI as the mediator included IQ as a control variable.

Emotional Intelligence. While self-reported trait measures of EI have been useful in predicting outcomes such as job performance (Joseph, Jin, Newman, & O'Boyle, 2015), there have been criticisms for using these types of assessments for EI. Specifically, trait EI has been argued to be a poor measurement because perceptions of emotional ability are only weakly related to actual ability levels (MacCann, Matthews, Zeidner, & Roberts, 2003). Self-reported trait EI measures also reportedly lack psychometric support, particularly discriminant validity, as nearly all of these trait EI measures overlap with personality dimensions (Conte & Dean, 2006). Given these criticisms and concerns, this study utilizes an ability-based EI measure rather than a trait-based EI measure.

Emotional intelligence (EI) was measured using the Mayer-Salovey-Caruso Emotional Intelligence Test (MSCEIT) version 2.0 (Mayer, Salovey, & Caruso, 2002). This 141-item performance-based test was designed to measure EI in adults 17 years and older. The MSCEIT reflects an individual's ability to perceive, manage, and reason about emotions using pictures of faces to gauge visual emotion identification as well as mini-vignettes of emotional scenarios to assess how well individuals can regulate and use their emotions to inform decisions. In a review and critique of self-report trait and ability-based measures of EI, ability-based EI (the MSCEIT and its predecessor, the MEIS) was found to be most promising because of its greater discriminant validity and greater incremental validity beyond predictors such as cognitive ability and personality dimensions (Conte & Dean). We followed the guideline made in the MSCEIT user manual[25] which recommends analyses at the overall EI level as the overall EI measure has higher internal consistency compared to sub-tests (Matthews, Zeidner, & Roberts, 2002).

Psychopathy. Psychopathic traits were assessed using the Psychopathy Checklist-Revised: 2nd edition (PCL-R; Hare, 2003). Ratings were made by one of the authors (RS) who received systematic training on the administration and scoring of the PCL-R by Robert D. Hare and Adelle Forth—including the completion of a series of PCL-R assessments on standardized, videotaped case histories of adult male offenders (Pearson's *r* correlations between rater's and standardized criterion scores: Total PCL-R = .92, Factor 1 = .93, and Factor 2 = .91). Assessments were supervised by the second author (AR) who has had extensive experience in the assessment of psychopathy. Ten sources of objective collateral data, including structured and semi-structured clinical interviews as well as professional web-based background check services, were utilized for ratings (see Gao, Raine, & Schug for a full description). The PCL provides seven different scores: total psychopathy, Factors 1 (Interpersonal-Affective) and 2 (Lifestyle-Antisocial), as well as facets 1 (Interpersonal), 2 (Affective), 3 (Lifestyle), and 4 (Antisocial). The structure of the PCL-R is illustrated in Figure 1. All seven scores of the PCL-R were examined as outcome variables to test replicability of any findings across different aspects of psychopathy.

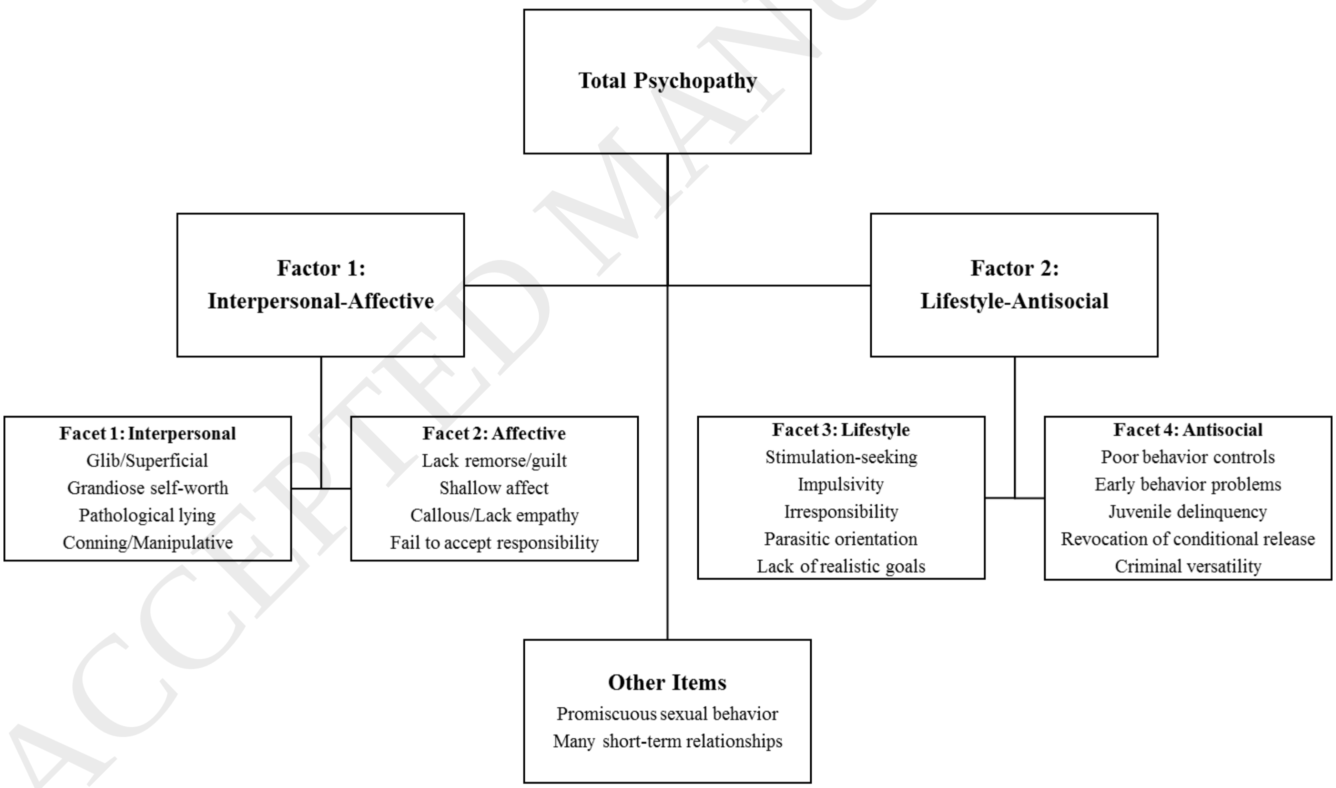

Figure 1. Illustration of the PCL-R hierarchy. Reproduced from Ling, Umbach, & Raine (in press).

Statistical Analyses

Bivariate correlations among the observed study variables were performed using SPSS statistical software (IBM SPSS Statistics Version 21.0). Hayes' PROCESS macro, an SPSS add-on tool designed to aid in statistical mediation analyses, was used for the mediation analysis (Hayes, 2012; Hayes, 2013). PROCESS uses the bootstrapping method, where the sampling distribution of the conditional indirect effect is not assumed to be normal, to test estimated indirect effects (Hayes, 2012; Hayes 2013). Bootstrapping is considered to make more realistic assumptions about the sampling distribution of indirect effects and has higher statistical power than the traditional Sobel test (MacKinnon, Lockwood, & Williams, 2004). Mediation analyses were run using PROCESS's mediation model 4 (for single or parallel mediators) with 10,000 bootstrapped samples. The estimate of each indirect effect was quantified as the product of two ordinary least squares (OLS) regression coefficients: one between EI and autonomic stress activation (i.e., skin conductance or heart rate) and the second between psychopathic traits and EI while controlling for autonomic stress activity. A bias-corrected 95% bootstrap confidence interval for the product of these paths suggested a mediation effect of EI. All reported regression coefficients are unstandardized. In this study, a full mediation effect is defined as a significant indirect effect and a non-significant direct effect (i.e., an "indirect-only" mediation); a partial mediation effect is defined as a significant indirect effect and a significant direct effect (i.e., complementary mediation if direct and indirect effect signs are the same, and competitive mediation if direct and indirect effect signs are opposite; MacKinnon, Krull, & Lockwood, 2000; Zhao, Lynch, & Chen, 2010). No mediation effect is observed if the indirect effect is non-significant.

Imputation. There were 5.96% of heart rate values and 4.12% of skin conductance values missing. Missing heart rate data was imputed by averaging the neighboring valid values while missing skin conductance values were imputed using the preceding valid value.

Results

Descriptive statistics and bivariate correlations are provided (Table 1). Bivariate correlations revealed that EI, psychopathy, and the autonomic functioning variables were significantly associated with each other in the expected directions. IQ was only associated with EI, in a positive direction.

Table 1

Descriptive Statistics and Bivariate Pearson Correlations between Study Variables (n = 156)

Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**
(1) Heart Rate	1										
(2) Skin Conductance	.31**	1									
(3) Emotional Intelligence	.25*	.20*	1								
(4) Cognitive Intelligence	.02	.04	.31**	1							
(5) Total Psychopathy (Total)	-.23**	-.22**	-.28**	-.06	1						
(6) Interpersonal-Affective (Factor 1)	-.21*	-.24**	-.23*	-.02	.92**	1					
(7) Interpersonal (Facet 1)	-.19*	-.23**	-.26**	-.02	.81**	.91**	1				
(8) Affective (Facet 2)	-.20*	-.22*	-.17	-.01	.89**	.95**	.73**	1			
(9) Lifestyle-Antisocial (Factor 2)	-.20*	-.15	-.27**	-.08	.94**	.76**	.64**	.75**	1		
(10) Lifestyle (Facet 3)	-.15	-.13	-.23*	-.08	.86**	.69**	.58**	.70**	.91**	1	
(11) Antisocial (Facet 4)	-.22*	-.14	-.27**	-.07	.81**	.65**	.56**	.64**	.86**	.58**	1
M	78.2	10.4	39.2	98.2	18.8	8.4	3.9	4.5	9.0	5.3	3.6
SD	15.5	6.3	25.9	15.3	8.9	4.2	2.0	2.5	4.6	2.8	2.4

Note. Heart Rate = Average heart rate during social stressor task, measured as beats per minute. Skin Conductance = Average skin conductance level during social stressor task, measured as microsiemens. Emotional Intelligence = Overall MSCEIT EI percentile score. Cognitive Intelligence = Prorated subscales of WAIS-III. Psychopathy based upon PCL-R total and sub-scores. $^{*}p < .05$. $^{**}p < .01$.

Total Psychopathy

EI significantly mediated the relationship between total psychopathy and autonomic stress activity, regardless of whether skin conductance or heart rate was used as a measure of autonomic functioning (Table 2). After controlling for IQ, skin conductance level was positively associated with overall EI (b = .774, p = .043), which in turn was negatively associated with psychopathic traits (b = −0.114, p = .002; Figure 1a). EI fully mediated this relationship and accounted for 36.5% of the total effect of skin conductance on psychopathy. Heart rate was also positively associated with overall EI (b = .381, p = .023), which was negatively associated with psychopathic traits (b = −0.110, p = .003) after controlling for IQ (Figure 1b). EI fully mediated this relationship and accounted for 28.4% of the total effect of heart rate on psychopathy.

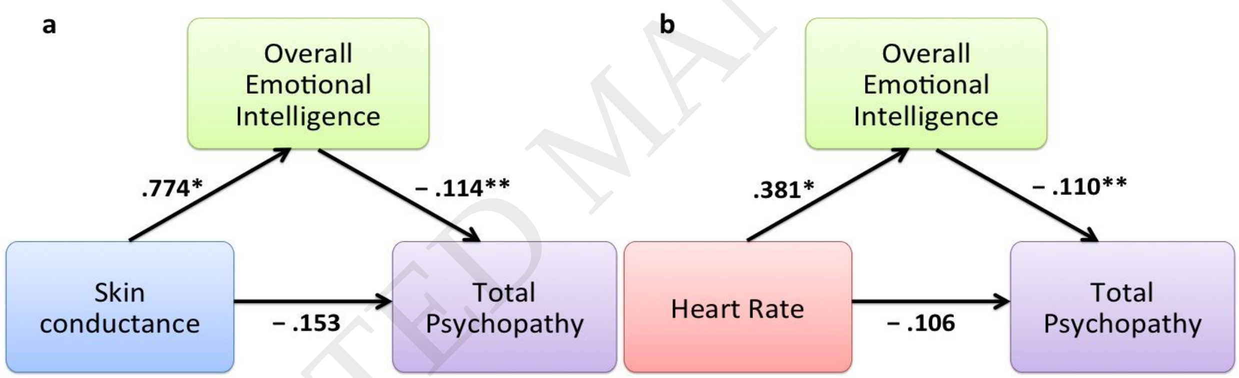

Figure 1. Results of EI mediation analyses, controlling for IQ: (a) EI fully mediates the relationship between skin conductance and total psychopathy and (b) EI fully mediates the relationship between heart rate and total psychopathy. *p < .05. **p < .01.

After establishing that overall EI mediated the relationship between autonomic stress activity and total psychopathy, the factors and facets of psychopathy were examined to evaluate whether reduced EI deficits were found for all features of psychopathy. The mediation models for the psychopathy factors and facets are included as Supplementary Materials.

Psychopathy factors. The mediation analyses were repeated using the Interpersonal-Affective and Lifestyle-Antisocial factors as outcomes while controlling for IQ (Table 2).

In the skin conductance mediation model, increased EI reduced both the Interpersonal-Affective ($b = -0.042$, $p = .012$; Figure S1a) and Lifestyle-Antisocial factors ($b = -0.060$, $p = .002$; Figure S2a). EI was a full mediator for these relationships and accounted for 25.2% of the total effect of skin conductance for the Interpersonal-Affective factor, and 69.7% of the total effect between skin conductance and the Lifestyle-Antisocial factor.

In the heart rate mediation model, EI reduced the Interpersonal-Affective factor ($b = -0.041$, $p = .013$; Figure S1b) and the Lifestyle-Antisocial factor ($b = -0.056$, $p = .003$; Figure S2b). EI fully mediated these relationships and accounted for 23.5% of the total effect of heart rate for the Interpersonal-Affective factor, and 31.8% of the total effect of heart rate for the Lifestyle-Antisocial factor.

Psychopathy facets. Each facet was examined as an outcome measure in the mediation analysis, again controlling for IQ (Table 2).

In the skin conductance mediation model, EI reduced the Interpersonal ($b = -0.022$, $p = .005$; Figure S3a), Affective ($b = -0.020$, $p = .046$; Figure S4a), Lifestyle ($b = -0.034$, $p = .003$; Figure S5a), and Antisocial ($b = -0.028$, $p = .006$; Figure S6a) facets. EI fully mediated the relationship between skin conductance and each facet. EI accounted for 27.0% of the total effect of skin conductance on Interpersonal features, 22.7% of the total effect of skin conductance on Affective features, 81.3% of the total effect of skin conductance on Lifestyle features, and 59.5% of the total effect of skin conductance on Antisocial features.

In the heart rate mediation model, EI reduced the Interpersonal ($b = -0.022$, $p = .006$; Figure S3b), Affective ($b = -0.020$, $p = .050$; Figure S4b), Lifestyle ($b = -0.033$, $p = .004$; Figure

S5b) and Antisocial ($b = -0.024$, $p = .016$; Figure S6b). EI fully mediated the relationship between heart rate and Interpersonal, Affective, and Lifestyle features, but only partially mediated Antisocial features. EI accounted for 23.5% of the total effect of heart rate on Interpersonal features, 23.5% of the total effect of heart rate on Affective features, 50% of the total effect of heart rate on Lifestyle features, and 21.4% of the total effect of heart rate on Antisocial features.

Cognitive Intelligence Mediation Analyses

While we controlled for IQ in the above EI mediation analyses, as an additional sensitivity analysis we tested the reverse counter-hypothesis (which we did not predict) that cognitive IQ mediates the autonomic – psychopathy relationship after controlling for EI (Table 2). Analyses were run with IQ as the mediating variable and EI as the control variable. Results indicate that IQ was not a mediator between any ANS measure and any psychopathy measure (see Sensitivity Analyses in Supplemental Materials).

Table 2

Mediation Results between Study Variables

	EI as mediator, controlling for IQ		IQ as mediator, controlling for EI	
Outcome	SC	HR	SC	HR
Total Psychopathy (PCL-R)	Full	Full	NS	NS
PCL-R Factor 1 (Interpersonal-Affective)	Full	Full	NS	NS
PCL-R Factor 2 (Lifestyle-Antisocial)	Full	Full	NS	NS
PCL-R Facet 1 (Interpersonal)	Full	Full	NS	NS
PCL-R Facet 2 (Affective)	Full	Full	NS	NS
PCL-R Facet 3 (Lifestyle)	Full	Full	NS	NS
PCL-R Facet 4 (Antisocial)	Full	Partial	NS	NS

SC = skin conductance. HR = heart rate. PCL-R = Psychopathy Checklist-Revised. EI = emotional intelligence. IQ = cognitive intelligence. Full = Full mediation. Partial = Partial mediation. NS = non-significant mediation.

Discussion

This study aimed to test whether: (1) EI mediated the autonomic – psychopathy relationship, (2) EI mediational effects are found for all features of psychopathy, and (3) these effects were independent of IQ. Our findings indicate that blunted ANS activity is associated with increased psychopathy. Further analyses reveal that low EI is associated with all psychopathy features. Analyses with the two psychopathy factors and four facets show that EI mediates the relationship between autonomic stress activation (regardless of whether it is measured by skin conductance or heart rate) and psychopathy (regardless of whether it reflects total psychopathy or a specific aspect of psychopathy), indicating robustness of findings. With one exception, full mediation was observed. Moreover, these results are significant after controlling for cognitive intelligence, documenting specificity to EI. To our knowledge, this is the first study to show the mediating effect of EI on the relationship between autonomic functioning during stress and psychopathy.

Our first hypothesis proposed that EI would mediate the autonomic functioning – psychopathy relationship, while our second hypothesis proposed that EI would mediate all features of psychopathy. These hypotheses were broadly supported, with one exception. We found that EI was a full mediator of skin conductance and all psychopathy facets. For heart rate however, while EI fully mediated the first three facets, it was only a partial and complementary mediator of the Antisocial aspect of psychopathy (PCL-R facet 4) (Zhao, Lynch & Chen, 2010). This suggests that while low heart rate may be associated with antisocial behavior by reducing EI, low heart rate is associated with antisociality beyond its effect on EI. Low heart rate, particularly during a stressor, is a robust and well-replicated correlate of antisocial behavior (Ortiz & Raine, 2004), captured in facet 4 of the PCL-R. Low heart rate is associated with increased impulsive sensation-seeking behavior, a construct not captured by EI, but which has been found to mediate the heart rate –

antisocial relationship (Portnoy et al., 2014; Sijtsema et al., 2010; Wilson & Scarpa, 2011). As such, it is likely that there are factors other than EI that are influenced by low heart rate and might also be associated with psychopathy. Furthermore, the fact that findings for facet 4 were different to facets 1, 2, and 3 for heart rate bears on the debate as to whether criminality is an essential feature of psychopathy (Hare & Neumann, 2010; Skeem & Cooke, 2010). Despite this one exception, our results otherwise suggest reduced EI fully mediates the autonomic functioning – psychopathy relationship across all other features of psychopathy.

Our third hypothesis assessed whether any effects of EI as a mediator were independent of IQ. EI was found to positively correlate with IQ (r = .305). Alternative analyses were run with IQ as the mediator and EI as a control but all models yielded non-significant results. This lends support to the view that not only is EI a potentially important process in understanding how reduced autonomic functioning is associated with psychopathic features, but also that cognitive intelligence cannot be a substitute for emotional intelligence.

Theoretical Contexts

The somatic marker hypothesis provides one framework for understanding our findings (Damasio, 1994). Under this model, blunted ANS functioning is argued to predispose to impaired emotional functioning and psychopathic-like traits. However, alternative models are possible. For example, it is conceivable that living a psychopathic way of life could predispose to later blunted ANS functioning, rather than vice-versa. To the authors' knowledge, this alternative perspective does not appear to have been previously tested, although it is worth considering. Previously normal individuals who suffer damage to the ventral prefrontal cortex progress to developing both blunted ANS functioning as well as psychopathic-like traits (Bechara, Damasio, & Damasio, 2000), although the temporal ordering of these latter two developmental outcomes of ventral prefrontal injury has not been fully elucidated. Alternative mediation models were conducted to test the perspective that psychopathy instead predisposes to blunted ANS functioning (see Supplemental Materials), but these alternative models were non-significant. Nevertheless, the concurrent assessment of the measures in this study are an important limitation to acknowledge. Clearly, prospective longitudinal research is required to test between these two possibilities.

Another theoretical perspective within which to view the current results is the somatic aphasia hypothesis (Gao, Raine, & Schug, 2012). This perspective suggests that psychopathic individuals suffer from somatic aphasia - the inaccurate identification and recognition of their own bodily states (Gao, Raine, & Schug, 2012). It was documented that subjective reports of bodily reactions to stress (e.g. sweating palms, racing heart) are more poorly associated with objective autonomic indicators of stress activity in psychopaths compared to non-psychopaths. This somatic aphasia, hypothesized to stem from blunted autonomic functioning, may predispose to psychopathy, but it is unclear whether somatic aphasia follows from low EI, or alternatively if it predisposes to low EI. Additionally, poor fear conditioning is a well-replicated correlate of psychopathic behavior (Birbaumer et al., 2005) but its role within this broader theoretical framework on EI is also unclear. Future longitudinal mediational research that incorporates these measures would be required to better tease out temporal ordering to better understand why blunted autonomic functioning may predispose to psychopathic traits.

Clinical Implications

Regarding future treatment and prevention implications, because EI may be more fluid than cognitive intelligence, it may be possible to alter an individual's psychopathic predisposition by promoting the development of EI. If EI can be improved through learning, it may be beneficial to evaluate educational programs that strive to improve EI to assess their effectiveness in decreasing subsequent antisocial behaviors. Randomized controlled trials aimed at improving EI may help to improve the well-being of individuals with psychopathic features, foster pro-social behaviors, and reduce recidivism. Importantly, experimental interventions that promote EI may provide opportunities to empirically test the model that our initial study proffers. EI interventions have been shown to improve EI (Nelis, Quoidbach, Mikolaiczak, & Hansenne, 2009; Pool & Qualter, 2012), and an EI intervention on middle and high school students both enhanced empathy and reduced aggression (Castillo, Salguero, Fernandez-Berrocal, & Balluerka, 2013). As such, from a developmental perspective there could be value in EI interventions applied to juveniles who show psychopathic traits, with the potential to prevent adult psychopathy. Research on the efficacy of EI training programs in the workplace suggests improvements of EI in adults (Groves, McEnrue, & Shen, 2008; Kirk, Schutte & Hine, 2011; Slaski & Cartwright, 2003) and improvements in work and health outcomes, with the effect of EI training on subsequent emotional intelligence having a moderate effect size ($g = 0.46$, [0.10, 0.83], Q (5) = 16.76, $p = .005$; Schutte, Malouff, & Thorsteinsson, 2013). Nevertheless, research on whether EI improvements can lead to a decrease in antisocial behavior in particular in adult samples has been lacking.

While EI interventions have shown success in community samples, it could be useful to evaluate EI intervention programs on antisocial populations to determine their effectiveness. EI enhancement programs may be particularly useful for offenders as EI is lower in convicted offenders (Sharma, Prakash, Sengar, Chaudhury, & Singh, 2015) and is lowest for murderers (Megreya, 2015). If clinical trials and experimental interventions show that EI interventions are helpful, forensic practitioners working with psychopathic clients in these settings may benefit from a focus on EI when conducting risk assessments and formulating treatment strategies for these individuals. Additionally, while our study examined the relationship between autonomic functioning, EI, and psychopathic traits in adults, it is also important to determine whether such a relationship is found in younger populations such as children and adolescents. If so, earlier EI interventions could be offered to prevent adolescents with callous-unemotional traits from developing into psychopathic adults. Psychopathy may be a difficult condition to treat (Frick, Ray, Thornton, & Kahn, 2014), but understanding that EI is one construct that could predispose an individual to psychopathic traits could give researchers and therapists a potential future intervention target that can be changed to prevent the development of psychopathy.

Limitations

There are several limitations to this study that should be recognized. First, while mediation analysis can assess the fit of data to a causal model, it cannot test causality. Moreover, although the term “full” mediation is used to describe some of the results, this should not be interpreted as an indication that the relationship between autonomic functioning and psychopathy is fully explained. Rather, “full” and “partial” mediation has been used in this study to distinguish a significant indirect effect with a non-significant direct effect (i.e., “full” mediation) or a significant indirect effect with a significant direct effect (i.e., “partial” mediation). Indeed, the extent of mediation ranged from 21.4% to 81.3%., indicating that factors other than EI likely play a role in the ANS – psychopathy relationship. Second, the use of a cross-sectional research design limits the ability to establish the temporal sequence of events from blunted ANS activity through decreased EI to increased psychopathic tendencies. Nevertheless, cross-sectional and correlational data can still be used in mediation models (Hayes, 2013). However, longitudinal studies would be needed to establish the temporal ordering of events to make causality more plausible. More sophisticated analytical methods such as path analyses or structural equation modeling may also provide stronger support for our model. Moreover, although our results were statistically significant, effect sizes were not large, falling between small and medium ($r = -.219$ for skin conductance and $r = -.225$ for heart rate), indicating that autonomic impairments are clearly not the sole risk factor for psychopathic traits.

Additionally, this study only examined adult males, thus it is unclear whether these results would generalize to other populations. Future studies may consider examining the extent to which emotional intelligence programs can improve the socioemotional development of antisocial youth. It would also be important to consider whether there would be differences in socio-emotional training efficacy between antisocial youth with and without callous-unemotional traits (Frick & White, 2007). There may also be gender differences, given that males and females differ in psychophysiological functioning during stress (e.g., O'Leary, Loney, & Eckel, 2007; Verma, Balhara, & Gupta, 2011), emotional intelligence (e.g., Salovey, Brackett, & Mayer, 2004), and psychopathic traits (e.g., Hamburger, Lilienfeld, & Hogben, 1996). The ethnic distribution of our sample may also limit the generalizability of our study.

As discussed above, there has also been debate on whether antisocial behavior should be included in a definition of psychopathy (Hare & Neumann, 2010b; Skeem & Cooke, 2010). Although we found a full mediation effect for the interpersonal, affective, and lifestyle facets of psychopathy and only a partial mediation effect for the antisocial facet, it is nevertheless unclear whether an alternative assessment of psychopathy without the inclusion of antisociality would yield the same results. Although the role of antisocial behavior in the definition of psychopathy is beyond the scope of this paper, future studies may consider examining whether our results can be generalized to other definitions of psychopathy.

Lastly, there are limitations to the use of ANS assessment in this study. Although this study assessed ANS activity using two autonomic indicators, in reality autonomic functioning involves a wide variety of complex patterns (Janig & Habler, 2000), and ANS measures such as heart rate and skin conductance do not always covary in the same direction (Lacey, 1967). Nevertheless, despite heart rate and skin conductance reflecting different autonomic processes, we find similar results for both measures, suggesting that blunted autonomic functioning is a robust correlate of psychopathy and emotional intelligence. Future studies should take into account the complexity of the ANS anatomy and physiology, and consider possible confounders that could affect ANS functioning such as substance use, medication use, and body mass index. While our study suggests that reduced autonomic functioning is associated with psychopathy by impairing emotional intelligence, it is unclear whether reduced or heightened autonomic functioning is inherently good/adaptive or bad/deleterious. Although such an examination falls outside the scope of this paper and reduced autonomic functioning has traditionally been considered to be maladaptive in the context of antisocial outcomes and classical conditioning paradigms (Aniskiewicz, 1979; Hare & Quinn, 1971; Lorber, 2004; Raine, Lencz, Bihrle, LaCasse, & Colletti, 2000), future studies may consider testing this assumption. It also should be emphasized that the autonomic measures used in this study are measures taken during a stress task but should not be taken as measures of autonomic stress *reactivity*, as they reflect a combination of both low autonomic arousal as well as low stress reactivity. This approach follows from our prior work on autonomic activity during a stressor (Choy et al., 2015; Raine et al., 2000).

Conclusions

While blunted autonomic functioning is a well-established correlate of psychopathy, few studies have attempted to identify the processes underlying this relationship. Here we show, for the first time, that blunted autonomic functioning is associated with reduced EI, which in turn is associated with psychopathy, establishing low EI as a candidate mediator of this relationship. By identifying putative mechanisms of action, the future promise lies in the potential to upregulate EI in at-risk adolescents and prevent psychopathy, a condition that produces enormous costs to society. While EI interventions have shown promising results for non-antisocial populations, it remains to be seen whether they can reduce psychopathic traits and provide more substantive experimental support for the initial model that we propose here.

References

Aniskiewicz, A. S. (1979). Autonomic components of vicarious conditioning and psychopathy. *Journal of Clinical Psychology, 35*, 60 – 67.

Baker, L. A., Tuvblad, C., Reynolds, C., Zheng, M., Lozano, D. I. & Raine, A. (2009). Resting heart rate and the development of antisocial behavior from age 9 to 14: Genetic and environmental influences. *Developmental Psychopathology, 21*: 939–960. doi: 10.1017/S0954579409000509.

Bechara, A., Damasio, H., & Damasio, A. R. (2000). Emotion, decision-making and the orbitofrontal cortex. *Cerebral Cortex, 10*: 295–307.

Beda, A., Jandre, F. C., Phillips, D. I. W., Giannella-Neto, A., & Simpson, D. M. (2007). Heart-rate and blood-pressure variability during psychophysiological tasks involving speech: Influence of respiration. *Psychophysiology, 44*, 767 – 778.

Birbaumer, N., Veit, R., Lotze, M., Erb, M., Hermann, C., Grodd, W., & Flor, H. (2005). Deficient fear conditioning in psychopathy: A functional magnetic resonance imaging study. *Archives of General Psychiatry, 62*, 799 – 805.

Blair, R. J. R., Jones, L., Clark, F., & Smith, M. (1997). The psychopathic individual: A lack of responsiveness to distress cues? *Psychophysiology, 34*, 192 – 198.

Blair, R. J. R., Mitchell, D. G. V., Peschardt, K., Colledge, E., Leonard, R. A., Shine, J. H., & Perrett, D. I. (2004). Reduced sensitivity to others' fearful expressions in psychopathic individuals. *Personality and Individual Differences, 37*, 1111 – 1122.

Blair, R. J. R., Mitchell, D. G. V., Richell, R. A., Kelly, S., Leonard, A., Newman, C., & Scott, S. K. (2002). Turning a deaf ear to fear: Impaired recognition of vocal affect in psychopathic individuals. *Journal of Abnormal Psychology, 111*, 682 – 686.

Boucsein, W. (2012). *Electrodermal activity* (2nd ed.). New York: Springer.

Castillo, R., Salguero, J. M., Fernandez-Berrocal, P., & Balluerka, N. (2013). Effects of an emotional intelligence intervention on aggression and empathy among adolescents. *Journal of Adolescence, 36*: 883–892. doi:10.1016/j.adolescence.2013.07.001

Choy, O., Raine, A., Portnoy, J., Rudo-Hutt, A., Gao, Y., & Soyfer, L. (2015). The mediating role of heart rate on the social adversity – antisocial behavior relationship: A social neurocriminology perspective. *Journal of Research in Crime and Delinquency, 52*, 303 – 341.

Coleman, A. (2008). *A Dictionary of Psychology (3rd ed.).* Oxford University Press.

Conte, J. M. & Dean, M. A. (2006). Can emotional intelligence be measured? In K. R. Murphy (Ed.), *A critique of emotional intelligence* (pp. 59–77). Mahwah, NJ: Erlbaum.

Copestake, S., Gray, N. S., & Snowden, R. J. (2013). Emotional intelligence and psychopathy: A comparison of trait and ability measures. *Emotion, 13*: 691–702. doi: 10.1037/a0031746.

Damasio, A. (1994). *Descartes' Error: Emotion, Reason, and the Human Brain.* New York: Grosset/Putnam Books.

Damasio, A. R. (2000). A neural basis for sociopathy. *Archives of General Psychiatry, 57*: 128–129.

Dawel, A., O'Kearney, R., McKone, E., & Palermo, R. (2012). Not just fear and sadness: Meta-analytic evidence of pervasive emotion recognition deficits for facial and vocal expressions in psychopathy. *Neuroscience & Biobehavioral Reviews, 36*, 2288 – 2304.

Ermer, E., Kahn, R. E., Salovey, P., & Kiehl, K. A. (2012). Emotional intelligence in incarcerated men with psychopathic traits. *Journal of Personality and Social Psychology, 103*: 194–204. doi: 10.1037/a0027328

Fix, R. L. & Fix, S. T. (2015). Trait psychopathy, emotional intelligence, and criminal thinking: Predicting illegal behavior among college students. *International Journal of Law and Psychiatry, 42-43*: 183–188. doi: 10.1016/j.ijlp.2015.08.024

Frick, P. J., Ray, J. V., Thornton, L. C., & Kahn, R. E. (2014). Can callous-unemotional traits enhance the understanding, diagnosis, and treatment of serious conduct problems in children and adolescents? A comprehensive review. *Psychological Bulletin, 140*: 1–57. doi: 10.1037/a0033076

Frick, P. J. & White, S. F. (2008). Research review: The importance of callous-unemotional traits for developmental models of aggressive and antisocial behavior. *The Journal of Child Psychology and Psychiatry, 49*, 359 – 375.

Gao, Y., Raine, A., & Schug, R. A. (2011). P3 event-related potentials and childhood maltreatment in successful and unsuccessful psychopaths. *Brain and Cognition, 77*, 176 – 182.

Gao, Y., Raine, A., & Schug, R. A. (2012). Somatic aphasia: Mismatch of body sensations with autonomic stress reactivity in psychopathy. *Biological Psychiatry, 90*: 228–233.

Glenn, A. L. & Raine, A. (2014). Neurocriminology: Implications for the punishment, prediction and prevention of criminal behaviour. *Nature Reviews Neuroscience, 15*: 54–63.

Groves, K. S., McEnrue, M. P., & Shen, W. (2008). Developing and measuring the emotional intelligence of leaders. *Journal of Management Development, 27*, 225 – 250.

Hamburger, M. E., Lilienfeld, S. O., & Hogben, M. (1996). Psychopathy, gender, and gender roles: Implications for antisocial and histrionic personality disorders. *Journal of Personality Disorders, 10*, 41 – 55.

Hare, R. D. (1965). Psychopathy, fear arousal, and anticipated pain. *Psychological Reports, 16*:

499–502. doi: 10.2466/pr0.1965.16.2.499

Hare, R. D. (2003). The Hare Psychopathy Checklist-Revised, (PCL-R) (2nd ed.) Multi-Health Systems, Toronto, Canada.

Hare, R. D. & Neumann, C. S. (2010a). Psychopathy: Assessment and forensic implications. In L. Malatesti & J. McMillan (Eds.) *Responsibility and Psychopathy: Interfacing Law, Psychiatry and Philosophy* (pp. 93–123). New York: Oxford University Press.

Hare, R. D. & Neumann, C. S. (2010b). The role of antisociality in the psychopathy construct: Comment on Skeem and Cooke (2010). *Psychological Assessment, 22,* 446 – 454.

Hare, R. D. & Quinn, M. J. (1971). Psychopathy and autonomic conditioning. *Journal of Abnormal Psychology, 77*, 223 – 235.

Hayes, A. F. (2012). PROCESS: A versatile computational tool for observed variable mediation, moderation, and conditional process modeling [White paper]. Retrieved from http://www.afhayes.com/ public/process2012.pdf

Hayes, A. F. (2013). Introduction to mediation, moderation, and conditional process analysis: A regression-based approach. New York, NY: Guilford Press.

Janig, W. & Habler, H. J. (2000). Specificity in the organization of the autonomic nervous system: A basis for precise neural regulation of hemeostatic and protective body functions. *Progress in Brain Research, 122*, 351 – 367.

Joseph, D. L., Jin, J., Newman, D. A., & O'Boyle, E. H. (2015). Why does self-reported emotional intelligence predict job performance? A meta-analytic investigation of mixed EI. *Journal of Applied Psychology*, *100*: 298–342. doi: 10.1037/a0037681.

Kirk, B. A., Schutte, N. S., & Hine, D. W. (2008). Development and preliminary validation of an emotional self-efficacy scale. *Personality and Individual Differences, 45*, 432 – 436.

Lacey, J. I. (1967). Somatic response patterning and stress: Some revisions of activation theory. In M. H. Appley & R. Trumbull (Eds.), *Psychological Stress* (pp. 14 – 37). New York: Appleton-Century-Crofts.

Lorber, M. F. (2004). Psychophysiology of aggression, psychopathy, and conduct problems: A meta-analysis. *Psychological Bulletin, 130*, 531 – 552.

MacCann, C., Matthews, G., Zeidner, M., & Roberts, R. D. (2003). Psychological assessment of emotional intelligence: A review of self-report and performance-based testing. *The International Journal of Organizational Analysis, 11*: 247–274. DOI: 10.1108/eb028975

MacKinnon, D. P., Krull, J. L., & Lockwood, C. M. (2000). Equivalence of the mediation, confounding and suppression effect. *Prevention Science, 1*, 173 – 181.

MacKinnon, D. P., Lockwood, C. M., & Williams, J. (2004). Confidence limits for the indirect effect: Distribution of the product and resampling methods. *Multivariate Behavioral Research, 39*: 99–128.

Marsh, A. A. (2013). What can we learn about emotion by studying psychopathy? *Frontiers in Human Neuroscience, 7:* 181.

Marsh, A. A. & Blair, R. J. R. (2008). Deficits in facial affect recognition among antisocial populations: A meta-analysis. *Neuroscience and Biobehavioral Reviews, 32*, 454 – 465.

Matthews, G., Zeidner, M., & Roberts, R. D. (2002). *Emotional intelligence: Science and Myth.* Cambridge, MA: MIT Press.

Mayer, J. D., Salovey, P., & Caruso, D. R. (2002). Mayer–Salovey–Caruso Emotional Intelligence Test (MSCEIT) user's manual. Toronto, Ontario, Canada: MHS, Inc.

Megreya, A. M. (2014). Emotional Intelligence and Criminal Behavior. *Journal of Forensic Sciences, 60*: 84–88.

Nelis, D., Quoidbach, J., Mikolajczak, M., & Hansenne, M. (2009). Increasing emotional intelligence: (How) is it possible? *Personality and Individual Differences*, *47*: 36–41. doi:10.1016/j.paid.2009.01.046

O'Leary, M. M., Loney, B. R., & Eckel, L. A. (2007). Gender differences in the association between psychopathic personality traits and cortisol response to induced stress. *Psychoneuroendocrinology, 32*, 183 – 191.

Ortiz, J. & Raine, A. (2004). Heart rate level and antisocial behavior in children and adolescents: A meta-analysis. *Journal of the American Academy of Child and Adolescent Psychiatry*, *43*: 154–162.

Patrick, C. J. (Ed.). (2006). Handbook of psychopathy. New York, NY: The Guilford Press.

Patrick, C. J., Bradley, M. M., & Lang, P. J. (1993). Emotion in the criminal psychopath: Startle reflex modulation. *Journal of Abnormal Psychology*, *102*, 82 – 92.

Patrick, C. J., Cuthbert, B. N., & Lang, P. J. (1994). Emotion in the criminal psychopath: Fear image processing. *Journal of Abnormal Psychology*, *103*, 523 – 534.

Pool, L. D. & Qualter, P. (2012). Improving emotional intelligence and emotional self-efficacy through a teaching intervention for university students. *Learning and Individual Differences, 22*: 306–312. doi:10.1016/j.lindif.2012.01.010

Portnoy, J. & Farrington, D. P. (2015). Resting heart rate and antisocial behavior: An updated systematic review and meta-analysis. *Aggression and Violent Behavior, 22*: 33–45. doi:10.1016/j.avb.2015.02.004

Portnoy, J., Raine, A., Chen, F. R., Pardini, D., Loeber, R., & Jennings, J. R. (2014). Heart rate and antisocial behavior: The mediating role of impulsive sensation seeking. *Criminology, 52*: 292–311. doi: 10.1111/1745-9125.12038

Raine, A., Lencz, T., Bihrle, S., LaCasse, L., & Colletti, P. (2000). Reduced prefrontal gray matter volume and reduced autonomic activity in antisocial personality disorder. *Archives of General Psychiatry, 57*: 119–127.

Raine, A., Yang, Y., Narr, K., & Toga, A. (2009). Sex differences in orbitofrontal gray as a partial explanation for sex differences in antisocial personality. *Molecular Psychiatry*, *16*: 227–236.

Salovey, P., Brackett, M. A., & Mayer, J. D. (2004). *Emotional intelligence: Key readings on the Mayer and Salovey model*. Port Chester, NY: National Professional Resources, Inc./Dude Publishing.

Scerbo, A. S., Freedman, L. W., Raine, A., Dawson, M. E., & Venables, P. H. (1992). A major effect of recording site on measurement of electrodermal activity. *Psychophysiology*, *29*: 241–246. doi: 10.1111/j.1469-8986.1992.tb01693.x

Schutte, N. S., Malouff, J. M., & Thorsteinsson, E. B. (2013). Increasing emotional intelligence through training: Current status and future directions. *The International Journal of Emotional Education*, *5*, 56 – 72.

Sharma, N., Prakash, O., Sengar, K. S., Chaudhury, S., & Singh, A. R. (2015). The relation between emotional intelligence and criminal behavior: A study among convicted criminals. *Industrial Psychiatry Journal*, *24*: 54–58.

Sijtsema, J. J., Veenstra, R., Lindenberg, S., van Roon, A. M., Verhulst, F. C., Ormel, J., & Riese, H. (2010). Mediation of sensation seeking and behavioral inhibition on the relationship between heart rate and antisocial behavior: The TRAILS study. *Journal of the American Academy of Child and Adolescent Psychiatry*, *49*, 493 – 502.

Skeem J. L. & Cooke, D. J. (2010). Is criminal behavior a central component of psychopathy?

Conceptual directions for resolving the debate. *Psychological Assessment, 22,* 433 – 445.

Slaski, M. & Cartwright, S. (2003). Emotional intelligence training and its implications for stress, health and performance. *Stress and Health, 19,* 233 – 239.

Verma, R., Balhara, Y. P., & Gupta, C. S. (2011). Gender differencse in stress response: Role of developmental and biological determinants. *Industrial Psychiatry Journal, 20,* 4 – 10.

Verona, E., Patrick, C. J., Curtin, J. J., Bradley, M. M., & Lang, P. J. (2004). Psychopathy and physiological response to emotionally evocative sounds. *Journal of Abnormal Psychology, 113*, 99 – 108.

Watts, A. L., Salekin, R. T., Harrison, N., Clark, A., Waldman, I. D., Vitacco, M. J., & Lilienfeld, S. O. (2016). Psychopathy: Relations with Three Conceptions of Intelligence. *Personality Disorders: Theory, Research, and Treatment, 7*: 269–279.

Wechsler, D. (1997). WAIS- III administration and scoring manual. San Antonio, TX: Psychological Corporation.

Wilson, K., Juodis, M., & Porter, S. (2011). Fear and loathing in psychopaths: A meta-analytic investigation of the facial affect recognition deficit. *Criminal Justice and Behavior, 38*, 659 – 668.

Wilson, L. C. & Scarpa, A. (2011). The link between sensation seeking and aggression: A meta-analytic review. *Aggressive Behavior, 37*, 81 – 90.

Zhao, X., Lynch Jr., J. G., Chen, Q. (2010). Reconsidering Baron and Kenny: Myths and truths about mediation analysis. *Journal of Consumer Research, 37*, 197 – 206.