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Personality Correlates of Physiological Response to Stress Among Incarcerated Juveniles

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Abstract

Background—To examine the relationship between personality type and physiological response to stress among juvenile delinquents.

Methods—Delinquent males (N=42, mean age 16.5, SD=1) recruited from a convenience sample at local juvenile detention facility were compared to a male control sample from a local high school (N=79; mean age 16.1, SD=0.8). All participants completed the Weinberger Adjustment Inventory and a Stress Inducing Speech Task while having heart rate measured.

Results—Delinquent youths showed significantly lower heart rates under both free association and stress conditions than controls ($p<0.05$) and a lower rate of increase during stressful stimuli ($p<0.05$). Among delinquents, those with a non-reactive personality type appeared to show consistently lower levels of physiological arousal as measured by heart rate.

Conclusions—Delinquents consistently had lower overall levels of arousal as measured by heart rate. In delinquent boys, we found a persistently low arousal group with a non-reactive psychological pattern. This combination may be a forerunner of future psychopathy or a product of the developmental trajectory that leads to and results from psychopathic behavior.

Introduction

Juvenile delinquency, as a research domain, has grown substantially over the past two decades. With this growth of scholarship has come the realization of the complex interaction between biological risk factors, individual psychological character traits, and social forces which combine to either produce or ameliorate juvenile delinquency.

Personality characteristics and autonomic arousal patterns have both been shown independently to predict risk for criminality, criminal recidivism, and psychopathology in youth (Moffitt 1996; Raine 1997; Steiner *et al.* 1999). Showing that criminals have different physiological profiles suggests an underlying predisposition that may have both environmental and genetic origins (Raine 1993). Steiner and colleagues found that

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Competing Interests

The authors have no competing interests to report with regard to the subject matter reported in this paper.

Authors' Contributions

Data collection was done by SM under the supervision of HS. Initial data analysis and drafting of the paper was done by NK and SM. Secondary statistical analyses were done by AP and LK. Final editing and revision of the paper were done by NK, AP, JB and HS.

“predicting” past crime paths in delinquent boys was successful when examining resting heart rates and personality characteristics (Steiner *et al.* 1999).

In another key study in this subfield, Adrian Raine et al.(1997) found in the Maritius Child Health Study that children at age three with low heart rates were predisposed to aggression at age eleven (Raine *et al.* 1997). Raine’s study was well designed with a large sample size and excellent follow-up. Nevertheless, the difference between high and low heart rate was very narrow (123 vs. 129). Despite the finding of difference, the narrow range makes use of the difference highly problematic as a screening or investigatory tool in clinical practice. This finding suggests that there is a biological component to the development of aggression but it is obvious that individual and social factors can affect or otherwise mitigate biological propensity. More recently, Herpertz and colleagues in studying boys with conduct disorder who have co-morbid ADHD found that conduct disorder correlates with lower emotional reactivity and overall lower autonomic arousal (Herpertz *et al.* 2005).

Developmental studies of criminality have yielded some insights. A longitudinal study of fifteen-year-olds found that when the boys reached the age of twenty-four, those who had a significantly lower heart rate had committed more crimes. These differences could not be accounted for by social, demographic, or academic factors (Raine and Liu 1998). Even when using a non-physiological measure of arousal, one study found an inverse relationship between arousability and the frequency and range of delinquent acts committed (Coren 1999).

Low resting heart rates may reflect an individual’s inability to fear social repercussions or what we have elsewhere termed “amorality” (Karnik and Steiner 2002). Individuals with autonomic under-arousal are thought to seek out stimulating events and are therefore attracted to dangerous and violent activities. Lorber in a recent meta-analysis of 95 studies found that there were complex interactions between aggression, psychopathy, and autonomic patterns (Lorber 2004). This study determined that low resting heart rate and high heart rate reactivity were associated with aggression and conduct problems. As such, these findings map on to our emerging understanding of juvenile aggression with two major pathways. One has been termed reactive, affective, defensive and impulsive (RADI) which is generally seen as “hot” aggression. The second form is proactive, instrumental and planned (PIP) which is seen as “cold” aggression (Karnik *et al.* 2006; Blair *et al.* Under Review). By disaggregating the overall group of conduct disorder, PIP likely correlates with low resting heart rate whereas RADI is more associated with high heart rate reactivity.

The present study aims to map arousal patterns onto personality characteristics in adolescent boys and examine the potential clinical implications. This study expands findings from previous studies by comparing incarcerated delinquent and non-delinquent boys, and by correlating adolescent personality and physiology. This study also seeks to combine findings from resting heart rates, heart rates in response to a standardized challenge, and standardized measures of personality in a delinquent and non-delinquent sample to examine clinical correlates to specific arousal characteristics that could open pathways to intervention.

Method

Design

Subjects provided informed consent, took psychometric exams and completed the Stress Inducing Speech Task (Steiner *et al.* 2002). When subjects completed the protocol they were asked if they had any questions, and were then debriefed.

Participants

Subject recruitment consisted of doctor suggestion, flyers, and by word of mouth at a local juvenile detention facility and a local high school. Both the incarcerated adolescents and the control group were samples of convenience. All participants were male. Participants included 42 male juvenile offenders diagnosed with severe conduct disorder and multiple co-morbidities based on clinical exam by providers at the facility. The mean age was 16.74 years (SD: 1.88), range 13–22. The control group included 79 adolescent males who were recruited from a local high school. Their mean age was 16.28 years (SD: 1.26) range 14–19. All participants were native speakers of English. The control group was paid \$20 for their participation. Subjects' parents or guardians provided informed consent, and subjects themselves gave assent to participate. The study was approved by the Stanford University Institutional Review Board.

Measures

Weinberger Adjustment Inventory (WAI-84) (Weinberger and Schwartz 1990)—

This 84-item self-report instrument measures personality characteristics and has been validated for use with both clinical and non-clinical populations across a wide range of ages. This nationally standardized inventory measures two primary dimensions that are distress (anxiety, depression, low self-esteem, and low well being) and self-restraint (impulse control, considerations of others, suppression of aggression, responsibility) with additional subscales for repressive defensiveness and denial of distress. The interactions of scores on the primary scales can be used to produce a typology of four adaptive styles (Figure 1) that predict different behavior potentials in juvenile delinquents, among others. The non-reactive profile has a 90% chance of re-arrest in the four and a half year span after release from detention, while the suppressor profile has an about 56% chance of relapse. In addition, we can generate an undifferentiated category, if the subjects' responses fall within one-half standard deviation on both axes in both directions. These children are thought not to be formed types, but types in development (Weinberger and Schwartz 1990; Steiner *et al.* 1999). For the purposes of this study, this questionnaire provides a baseline assessment of certain personality dimensions within the subject. Nine control subjects and 10 delinquent subjects failed to complete the WAI and therefore their measures were excluded from analyses which required the WAI.

The Stress Inducing Speech Task (SIST) (Steiner *et al.* 2002)—This task consists of two ten minute conditions 1) stress task – speaking about the most traumatic event that the subject has ever experienced 2) free association – speaking about any topic the subject wishes. Please see the Procedure section for greater detail.

Apparatus

While performing the SIST, subjects' heart rate responses were measured by means of Micronta blood pressure cuff that detected readings from an inflatable cuff that was put around the dominant arm of the subject. This setup allowed for continuous measurement of beats for a set period of time, which in this case was at baseline, at five minutes, and then at ten minutes into each task. The resulting heart rates were averaged for pulse for that period of measurement. This procedure was completely noninvasive, is often used in home self-monitoring of pulse and blood pressure and could be started and stopped at any time. It was chosen for its portability and resemblance to familiar clinical procedures.

Procedure

After filling out the assent forms, subjects were brought into a quiet, isolated, temperature- and humidity-controlled room and then they completed self-reports for the WAI. After the

completion of the self-report measures, the Micronta cuff was placed on the subject and there was a five minute rest period, from which a baseline heart rate measurement was obtained. Subjects were not permitted to eat or drink during the procedure.

After measuring the baseline pulse, the participant completed the SIST. It is a mildly to moderately stressful task in which subjects are asked to participate in two tasks. Each is a 10-minute audiotaped speech task on the following topics: Task 1: The most traumatic situation that the speaker has encountered in his past. Task 2: An unstructured free association period where the speaker discusses anything that he wishes. Presentation order of the two tasks, free association (FA) and the stress task (ST), was randomized. Subjects received instructions at the beginning of the SIST as to whether they would first talk about anything they wanted or discuss the most traumatic event of their lives.

Analyses

Correlations, t-tests, and chi-squares with Fischer's exact were applied as deemed appropriate. We calculated the area under the curve (AUC) using the baseline, 5 minute and 10 minute free association pulse rates as points on a curve. This was repeated with stress condition measures. Use of this technique allowed us to examine individual trends in reactivity to stress, controlling for baseline heart rate, within an aggregated dataset.. This provided a means for evaluating the data and an independent mechanism for assessing the difference between these populations without reliance on set heart rate parameters for low or normal groups. We also calculated the mean slope of increased heart rate to each event as another measure of the change in physiological arousal. Finally, in order to gain a broader view of our data, we conducted stem-and-leaf plots of heart rate at selected intervals in our process for each personality subtype to examine the ways that arousal correlated with personality type as defined by the WAI.

Results

Table 1 shows the WAI personality types that were present in our sample. Despite the crude differences in four quadrant personality types (Figure 1), the percentages when tested do not show statistical difference ($X^2=3.607$, $p=0.307$) by chi-square. In general we find that the delinquent group had higher percentages of reactive personality types and lower numbers of suppressor types in this sample. There were significant differences on portions of WAI subscale dimensions; denial of distress ($t = 4.27$, $p < .001$) and repressive defensiveness ($t = 3.61$, $p < .001$) were significantly higher in the delinquent population.

In examining the AUC and mean increase in heart rate we see a marked difference between the control and delinquent samples (Table 2). In both the stress and free association conditions, delinquents showed statistically lower responsiveness to stressors and less arousal overall. The stem-and-leaf plots for heart rate at each event point showed a consistent set of outcomes. Delinquents with non-reactive personality types repeatedly demonstrated the lowest average heart rate of any subgroup (cf. Figures 2, 3 & 4). In addition, delinquents with suppressor personality types showed the highest average heart rate of any subgroup. Post-hoc analyses of the pooled dataset showed that there was a trend towards significance ($p=0.056$) for difference between WAI subgroups when examining AUC in the stress condition. In this analysis, the non-reactive subgroup demonstrated the lowest physiological response in the stress condition.

Discussion

The major finding of this paper is a correlation between personality type and low physiological arousal under varied conditions. Delinquents consistently had lower overall

levels of arousal as measured by heart rate, and had blunted responses to stressful stimuli. Interestingly, we find that within the delinquent population non-reactive personality subgroup as defined by having low distress and low restraint in the WAI typology had consistently lower heart rates at each individual data point in our study and trends toward significance in pooled post-hoc analyses. These are the juveniles who would likely show higher rates of anti-sociality, as well as show little remorse or insight into their violations against the rights of others and society at large (Karnik and Steiner 2002). This subgroup may correspond to what is believed to be the PIP or “cold” form of aggression (Blair *et al.* Under Review).

This study attempted to address components of the human stress response, an important factor in the pathogenesis of psychopathology. In addition, this study was able to provide a continuous measure of arousal, linking *in vivo* with self-report. This investigation can integrate into and add to the existing literature by exposing possible mechanisms by which juvenile delinquents react to stress, thereby serving both clinical application and future research (Popma and Raine 2006).

Having subjects speak about their traumatic life events forces the individual to concentrate on the given topic. Previous research indicates that heart rate monitoring and, to a lesser degree, skin conductance assessment during audio-taped sessions of traumatic recollections appears to be a useful measure in studying those who have survived motor vehicle accidents, those with mixed trauma, and combat veterans. Such physiological assessment tools appear more problematic in the assessment of sexual trauma, but it is clear that psychophysiology should play a role in investigations of diagnoses and long-term outcome predictions for a variety of conditions (Saigh and Bremner 1999).

Limitations of this study include, the small sample sizes, and the participation of incarcerated juveniles with multiple co-morbidities (i.e. PTSD, antisocial personality disorder, conduct disorder), all of whom were at different stages of recovery. In addition, this study had no follow-up assessments, and no female subjects. There are several possible confounders in this study. First, both groups were evaluated at different sites which may have led to some difference in experience of the SIST. Attempts were made to minimize these differences by maintaining temperature constant and furniture layout in a similar fashion. Second, the delinquent youth described significantly more traumatic experiences than controls when performing on the SIST when reviewed qualitatively after the study. This could substantially affect the outcome of the study. But we would predict that this would increase heart rates and the degree of heart rate change. This did not occur. In fact, the delinquent youth showed less responsiveness to more traumatic recollections.

Future studies would benefit from larger sample sizes, and an analysis of female delinquent subjects. Also, multiple measures of arousal could be utilized, such as cortisol, skin-conductance, electroencephalogram, facial response and the non-physiological scales (Coren 1999). In addition, it would be interesting to compare future criminal records of those in the normal and low arousal groups to examine whether a differing pattern of criminality exists between arousal groups. Future research would also benefit from investigations into the possible protective factors of good psychophysiological functioning that could deter individuals from crime (Saigh and Bremner 1999). The physiological inability to respond to a stressful encounter in a normal fashion coupled with a personality profile lacking normal distress and restraint may help account for the violent, sensation-seeking behavior typical of life-course persistent pattern criminals.

Conclusions

The physiological correlates of delinquency are one major avenue for research. This study has demonstrated that personality type can be mapped onto physiological functioning, and that delinquent youth are more likely to exhibit lowered responsiveness to stressful stimuli when they have a non-reactive personality profile. While these results are preliminary and merit replication in a larger sample, they also provide researchers with a psychometric tool to approach delinquency.

List of Abbreviations Used

ADHD	Attention Deficit Hyperactivity Disorder
PIP	Proactive, Instrumental, Planned
RADI	Reactive, Affective, Defensive, Impulsive
SIST	Stress Inducing Speech Task
PTSD	Post Traumatic Stress Disorder
WAI	Weinberger Adjustment Inventory
AUC	Area Under the Curve

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References

- Blair RJ, Coccaro EF, Connor DF, Ferziger R, Hutchinson J, Karnik NS, Leibenluft E, Swann AC, Steiner H. Juvenile Maladaptive Aggression: A Review of the Neuroscientific Data. (Under Review).
- Coren S. Arousal predisposition as a predictor of antisocial and delinquent behavior. *Personality and Individual Difference*. 1999; 27:815–820.
- Herpertz SC, Mueller B, Qunaibi M, Lichterfeld C, Konrad K, Herpertz-Dahlmann B. Response to emotional stimuli in boys with conduct disorder. *Am J Psychiatry*. 2005; 162(6):1100–1107. [PubMed: 15930058]
- Karnik NS, McMullin MA, Steiner H. Disruptive behaviors: conduct and oppositional disorders in adolescents. *Adolesc Med Clin*. 2006; 17(1):97–114. [PubMed: 16473295]
- Karnik, NS.; Steiner, H. Adolescence, Incarceration & Experience: Toward a New Theory of Juvenile Psychopathy; Annual Meeting of the American Academy of Child and Adolescent Psychiatry; San Francisco, California. 2002.
- Lorber MF. Psychophysiology of aggression, psychopathy, and conduct problems: a meta-analysis. *Psychol Bull*. 2004; 130(4):531–552. [PubMed: 15250812]
- Moffitt TE. Measuring children's antisocial behaviors. *Jama*. 1996; 275(5):403–404. [PubMed: 8569022]
- Popma A, Raine A. Will future forensic assessment be neurobiological? *Child Adolesc Psychiatr Clin N Am*. 2006
- Raine A. Features of borderline personality and violence. *J Clin Psychol*. 1993; 49(2):277–281. [PubMed: 8486811]
- Raine, A. Biosocial bases of violence. New York: Plenum Press; 1997.
- Raine A, Liu J. Biological predispositions to violence and their implications for biosocial treatment and prevention. *Psychology, Crime & law*. 1998; 4(2):107–125.

- Raine A, Venables PH, Mednick SA. Low resting heart rate at age 3 years predisposes to aggression at age 11 years: evidence from the Mauritius Child Health Project. *J Am Acad Child Adolesc Psychiatry*. 1997; 36(10):1457–1464. [PubMed: 9334560]
- Saigh, PA.; Bremner, JD. *Posttraumatic stress disorder : a comprehensive text*. Boston: Allyn and Bacon; 1999.
- Steiner H, Cauffman E, Duxbury E. Personality traits in juvenile delinquents: relation to criminal behavior and recidivism. *J Am Acad Child Adolesc Psychiatry*. 1999; 38(3):256–262. [PubMed: 10087686]
- Steiner H, Ryst E, Berkowitz J, Gschwendt MA, Koopman C. Boys' and girls' responses to stress: affect and heart rate during a speech task. *J Adolesc Health*. 2002; 30 Suppl 1(4):14–21. [PubMed: 11943570]
- Weinberger D, Schwartz G. Distress and restraint at superordinate dimensions of adjustment: a typological perspective. *Journal of Personality*. 1990; 58:381–417. [PubMed: 2213473]

Figure 1.

Figure 2.

Free Association, 10 minutes

Figure 3.

Figure 4.

Table 1

Distribution of WAI Personality Types by Controls vs. Delinquents

WAI Type	Controls	Delinquents
Reactive	24.3%	40.6%
Suppressor	17.1%	9.4%
Non-Reactive	27.1%	28.1%
Repressor	31.4%	21.9%
N	70	32

Chi-square=3.607, p=0.307

Table 1

Difference between mean heart changes between controls and delinquents

Condition/Test	t	df	p	Mean C=control D=delinquent	Mean difference	Std. Error
Heart Rate AUC Stress Condition	2.369	96.191	<0.05	C 22.6266 D -3.4107	26.0373	10.99123
Heart Rate AUC Free Association Condition	2.152	97.218	<0.05	C 28.1329 D 4.3750	23.7579	11.03953
Heart Rate Mean Increase Stress Condition	2.567	98.932	<0.05	C 3.7089 D -0.3369	4.0458	1.57616
Heart Rate Mean Increase Free Association Condition	2.513	92.971	<0.05	C 5.2025 D 0.8631	4.3394	1.72707

Control (N) = 79; Delinquent (N) = 42