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P3 amplitude and psychopathic traits in youths: Distinct contributions of the grandiose-manipulative and daring-impulsivity traits



Yu Gao^{a,*}, Wei Zhang^b, Hedwig Eisenbarth^c, Annis Lai-Chu Fung^d, Matthew Lu^e, Adrian Raine^f, Tatia M.C. Lee^h, & Xiaobo Li^g

^a Department of Psychology, Brooklyn College and the Graduate Center of the City University of New York, Brooklyn, NY, United States

^b Department of Psychology, Queens College of the City University of New York, New York, NY, United States

^c Department of Psychology, University of Southampton, Southampton, UK

^d Department of Applied Social Sciences, City University of Hong Kong, Hong Kong, China

^e Department of Psychology, Brooklyn College of the City University of New York, Brooklyn, NY, United States

^f Departments of Criminology, Psychiatry, and Psychology, University of Pennsylvania, Philadelphia, PA, United States

^g Departments of Biomedical Engineering, Electrical and Computer Engineering, New Jersey Institute of Technology, NJ, United States

^h Department of Psychology, University of Hong Kong, Hong Kong, China

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ABSTRACT

Although abnormal P3 amplitude to target or novel stimuli have been found in adults with psychopathic traits, little is known about this relationship in youths and whether this P3 abnormality is differentially associated with dimensions of psychopathy. In this study 250 children and adolescents aged 8–19 years were assessed for P3 amplitudes in an auditory oddball paradigm over the left and right parietal sites. Psychopathic traits were assessed using combined child- and parent-reported scores on the Antisocial Process Screening Device (APSD; Frick & Hare, 2001). Although the zero-order correlations showed no significant associations between APSD factors and P3 amplitudes, when the factor scores were analyzed together in a regression analysis, the daring-impulsive traits (APSD impulsivity subscale) were negatively associated with the novelty P3, whereas the grandiose-manipulative traits (APSD narcissism subscale) were positively associated with the novelty P3 at the right parietal site. Results provide further support that varying dimension of psychopathic traits may relate to different neuronal pathway abnormalities, and highlight the importance of examining the suppressor effects between distinct aspects of psychopathy.

Psychopathic personality has been associated with various cognitive impairments, including abnormal allocation of attention as reflected by atypical P3 (or P300) responses (Gao & Raine, 2009). The P3 component of the event-related potentials (ERPs – which refer to averaged changes in the electrical activity of the brain in response to specific stimuli) is a positive brainwave deflection that occurs about 300 ms after the onset of the stimulus. In a typical three-stimulus oddball paradigm, participants are asked to detect an infrequent deviant tone (target; e.g., low-pitched tone) among a series of standard stimuli (non-target; e.g., high-pitched tone) and novel stimuli (e.g., dog barks, bird chirp). P3 to the targets (target P3 or P3b), maximally recorded at parietal sites, has been associated with the ability to identify the task relevance of a stimulus and actively engaging it for further action. In contrast, P3 to novel distractors (novelty P3 or P3a), maximally recorded at the frontal-central sites, has been implicated in evaluation of

qualitatively unique stimuli as well as response inhibition (see Polich (2007) for review). It is believed that novelty P3 reflects an involuntary automatic orientation of focused attention to novel stimuli and facilitate the allocation of attentional resources to successive memory storage operations in the hippocampal formation, whereas target P3 reflects this later controlled attentional process in the parietal regions (Polich, 2007). A series of studies have demonstrated P3 abnormalities in psychopathic adults, indicating atypical capability to direct attention to events of importance (e.g., Gao, Raine, & Schug (2011); Kiehl, Bates, Laurens, Hare, & Liddle (2006); Kiehl, Smith, Hare, & Liddle (2000)), and this impairment in neural processing of salient environmental stimuli has been postulated to predispose psychopathic individuals to antisocial and criminal behavior (Gao & Raine, 2009).

However, prior work has mainly focused on adults and different findings have been reported regarding target P3 responses in

* Corresponding author at: Department of Psychology, Brooklyn College, 5401 James Hall, 2900 Bedford Avenue, Brooklyn, NY 11210, United States.

E-mail addresses: yugao@brooklyn.cuny.edu (Y. Gao), wzhang2@gradcenter.cuny.edu (W. Zhang), H.Eisenbarth@soton.ac.uk (H. Eisenbarth), annis.fung@cityu.edu.hk (A.L.-C. Fung), araine@sas.upenn.edu (A. Raine), xiaobo.li@njit.edu (X. Li).

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psychopathy (see review by Gao & Raine (2009)). For example, whereas reduced target P3 responses have been found in some studies (Brazil et al., 2012; Kiehl et al., 2006; Kiehl, Hare, Liddle, & McDonald, 1999), enhanced P3 (Raine & Venables, 1987, 1988) or no associations (Jutai, Hare, & Connolly, 1987; Munro et al., 2007; Raine, 1993; Sydulko, Parker, Jens, Maltzman, & Ziskind, 1975) have been reported elsewhere. In addition, much fewer studies have examined novelty P3 responses in relation to psychopathy and the results have also been inconclusive. For example, Kiehl et al. (2006) reported reduced novelty P3, but only in one of the two psychopathic samples tested and no differences were found in the other sample. Gao et al. (2011) reported no differences in novelty P3 between controls, successful (uncaught) and unsuccessful (caught) psychopaths. A later study by Brazil et al. (2012) reported reduced novelty P3 amplitudes in psychopathic and non-psychopathic offenders. Taken together, the findings on psychopathy-based differences in the P3s are inconsistent and research on youths is lacking.

One approach to reconcile the inconsistent findings is by evaluating relations of distinguishable dimensions of psychopathy with P3 responses. Most conceptualizations describe psychopathy as a constellation of affective, interpersonal, and behavioral characteristics (Hare, 1991), and these separable trait dispositions may be associated with distinctive etiological processes. The interpersonal characteristics include narcissism, manipulativeness, superficial charm, egocentricity and glibness. The affective characteristics are defined by callousness, a lack of empathy and remorse, and short-lived emotions. Finally the behavioral characteristics include impulsivity, irresponsibility, proneness to boredom, novelty seeking, and antisociality. In children and adolescents, these three dimensions have been described as grandiose-manipulative (GM), callous-unemotional (CU), and daring-impulsive (DI) traits, respectively (Salekin, 2016). In this study, we aim to examine the unique relationships between P3 responses and these three dimensions in children and adolescents. Understanding an earlier manifestation of psychopathic traits and their neurobiological correlates, prior to the influence of harmful sequelae such as time spent in prison and substance abuse, may shed light on more successful early intervention (Frick, Ray, Thornton, & Kahn, 2014).

To date, only a few studies have examined P3 in relation to dimensions of psychopathy using an oddball paradigm, and all of them are with adult samples. For example, Venables and colleagues recorded P3 in a three-stimulus visual oddball task in incarcerated male offenders and reported that both novelty and target P3 amplitudes were negatively associated with scores on the impulsive-antisocial factor but unrelated to scores on the affective-interpersonal factor of psychopathy (Venables & Patrick, 2014). Using an auditory oddball task, Anderson et al. found target P3 amplitudes to be negatively associated with the interpersonal facet of psychopathy in incarcerated males, and no significant relationship between novelty P3 and facets was found (Anderson, Steele, Maurer, Bernat, & Kiehl, 2015). In a study with non-incarcerated adults, researchers reported a negative association between target P3 and impulsivity only (Carlson, Tháí, & McLarnon, 2009). Finally, in female undergraduate students, researchers found that higher psychopathy total scores were associated with target P3 augmentation, although neither factor could, alone, account for the overall effects on P3 (Anderson, Stanford, Wan, & Young, 2011). Clearly, more research is warranted to understand the effects of various dimensions of psychopathy on P3 measures.

Although the CU traits, i.e., a lack of guilt and an inability to show empathy and emotions, has received much attention in research in children and adolescents, the contribution of the remaining psychopathy dimensions, in particular the GM traits, is less clear (Feilhauer & Cima, 2013; Salekin, 2016). Narcissistic traits, included in the GM traits, have been shown to be a strong predictor for aggression and delinquency in addition to CU traits (Lau & Marsee, 2013). Furthermore, there are indicators for a positive correlation of CU traits with psychopathy-linked narcissism (Lee-Rowland, Barry,

Gillen, & Hansen, 2017). Interestingly, in adolescents who show an increase in CU traits and in conduct problems over the course of one year, narcissistic traits increase as well (Eisenbarth, Demetriou, Kyranides, & Fanti, 2016). Thus, the development and co-development of these traits can be assumed to have an impact on differential effects in underlying neurobiological mechanisms, and determining these correlates in youths is an important step in expanding our understanding of psychopathy.

The main goal of the present study was to assess neural processing of rare novel and target events in relation to different dimensions of psychopathic traits in youths. P3 amplitudes to targets, non-targets, and novel stimuli during an auditory oddball paradigm were recorded over the left and right parietal sites. As part of a more complex study on the effects of neurobiological, psychosocial, and omega-3 supplementation on antisocial behavior among schoolchildren, only two electrodes were utilized in the ERP sub-study due to time constraints. The left and right parietal sites were chosen for three reasons. First, they correspond to the temporal-parietal junction that is critically involved in the generation of P3 to target stimuli (Iwaki, Sutani, Kou, & Tonoike, 2007; Kiehl et al., 2001; Polich & Criado, 2006). Second, the key areas of the temporal-parietal junction, including the angular gyrus and the posterior superior temporal gyrus, have been implicated in a broad range of social cognition functions that are atypical in psychopathic and antisocial individuals, including representation of the mental states of others (Saxe & Kanwisher, 2003), empathy and moral decision-making (Decety & Lamm, 2007; Moll, de Oliveira-Souza, & Eslinger, 2003), and inhibition (Hedden & Gabrieli, 2010). P3 abnormalities at these sites may therefore reflect dysfunction of the temporal-parietal junction that is particularly relevant to psychopathy. Third, there is some suggestion that psychopathy is associated with reduced P3 asymmetry (Kiehl et al., 1999), therefore we hoped to explore the laterality issue in the current study.

Based on the converging findings that reduced P3 amplitude is a feature common to externalizing and antisocial traits (Yoon, Malone, & Iacono, 2015) and the impulsivity facet of psychopathy in adult samples (Venables & Patrick, 2014), diminished P3s to targets and novel stimuli were expected to be associated with the DI traits. We also expected P3 augmentation to be associated with the GM traits due to some suggestions that interpersonal features of psychopathy are associated with enhanced cognitive function (Bagshaw, Gray, & Snowden, 2014; Sellbom & Verona, 2007; however see Maes & Brazil (2013)). In addition, narcissism has been found to be associated with a deficit in central serotonergic inhibitory control as seen in a greater autonomic response in the context of threat (Kelsey, Ornduff, McCann, & Reiff, 2001), suggesting an over-attentiveness or hypersensitivity to stimuli signaling potential threat. CU traits were hypothesized to be unrelated to P3 responses. Although the distribution is fronto-central for the novelty P3 (Polich, 2007), an electrophysiological response to task-irrelevant novel stimuli can also be observed in parietal sites, and may be the “left-over” from the early autonomic orienting of focused attention reflected by the “real novelty P3” at fronto-central sites (Brazil et al., 2012). In this sense, we would investigate if psychopathic traits modulate how well information about the novel stimulus is transferred from fronto-central to parietal sites. Finally, although some evidence has suggested that psychopathic individuals exhibit reduced P3 asymmetry in response to visual stimuli (Kiehl et al., 1999), recent theorizing has not produced substantive lateralization theory of psychopathy. The effect of hemisphere was therefore examined in the current study although no prediction was made.

1. Methods

1.1. Participants

Participants were 301 Chinese students ages 8 to 19 years (mean age = 11.35, SD = 2.61, 63.5% male) from two local public schools in

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