Published in final edited form as:

Brain Cogn. 2011 November ; 77(2): 176–182. doi:10.1016/j.bandc.2011.06.010.

P3 event-related potentials and childhood maltreatment in successful and unsuccessful psychopaths

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Abstract

Although P3 event-related potential abnormalities have been found in psychopathic individuals, it is unknown whether successful (uncaught) psychopaths and unsuccessful (caught) psychopaths show similar deficits. In this study, P3 amplitude and latency were assessed from a community sample of 121 male adults using an auditory three-stimulus oddball task. Psychopathy was assessed using the Psychopathy Checklist-Revised (Hare, 2003) while childhood physical maltreatment was assessed using the Conflict Tactic Scale (Strauss, 1979). Results revealed that compared to normal controls, unsuccessful psychopaths showed reduced parietal P3 amplitudes to target stimuli and reported experienced more physical abuse in childhood. In contrast, successful psychopaths exhibited larger parietal P3 amplitude and shorter frontal P3 latency to irrelevant nontarget stimuli than unsuccessful psychopaths. This is the first report of electrophysiological processing differences between successful and unsuccessful psychopaths, possibly indicating neurocognitive and psychosocial distinctions between these two subtypes of psychopathy.

Keywords

Successful psychopaths; P3b; Novelty P3; Oddball; Childhood Abuse; Frontoparietal

Individuals with psychopathic personality are characterized by a constellation of traits, including interpersonal-affective features (e.g., superficial charm, manipulateness, lack of affect and emotion) and antisocial features (e.g., impulsivity and aggression; Hare, 2003). These traits in turn have been linked to violent and aggressive behavior (Porter & Woodworth, 2006). Although studies have generally indicated neurobiological deficits in incarcerated criminal psychopaths, little is known about whether “successful psychopaths” who escape conviction for the crimes they perpetrate are similar to institutionalized psychopaths in terms of psychophysiological and psychosocial risk factors.

One of the cognitive deficits found in psychopaths consists of an abnormality in the P3 (or P300), a positive-going electrophysiological waveform occurring approximately 300 milliseconds after stimulus onset. In a three-stimulus oddball paradigm, participants are

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asked to detect an infrequent deviant tone (target; e. g., low-pitched tone) amongst a series of standard stimuli (nontarget; e. g., high-pitched tone) and novel stimuli (e. g., dog barks, bird chirp). Two P3 components assess the participant's capability to direct attention to events of importance. First, a novelty P3, maximally recorded at frontal sites, is elicited by novel stimuli and is considered to be functionally related to the detection of novelty (Courchesne, Hillyard, & Galambos, 1975; Friedman & Simpson, 1994). Second, a P3b component, maximally recorded at parietal sites, is elicited during processing of the target stimulus and is viewed as reflecting relatively later conscious, decisional, and premotor response-related states (Polich, 2007). At the neuroanatomical level, it has been suggested that the locus coeruleus-norepinephrine (LC-NE) system underlies parietal P3b generation in a target detection task (Nieuwenhuis, Aston-Jones, & Cohen, 2005), whereas the novelty P3 is generally interpreted as reflecting frontal cortical activity related to the hippocampus and mediated by dopaminergic activity (Knight, 1996; Polich & Criado, 2006). Neuropsychologically, the novelty P3 is thought to reflect top-down control associated with attention allocation, whereas P3b involves a bottom-up control that promotes memory operations (see Polich, 2007 for an extensive review on differences between P3b and novelty P3). Some have also argued that the novelty P3 is considered to be an automatic response to salient stimuli, acting as a bottom-up gating mechanism (Knight, 1996).

The P3b, conversely, is dependent on a psychological set that defines the target as salient and therefore is more a result of top-down processing since it can be manipulated by conscious attention (e.g., Polich, 1986). Reduced P3b amplitude and longer latency have been found in caught criminal psychopaths (Kiehl, Bates, Laurens, Hare, & Liddle, 2006; Kiehl, Hare, Liddle, & McDonald, 1999), although some studies have reported enhanced P3 in unsuccessful psychopathic individuals (Raine & Venables, 1987, 1988) or no association (Jutai, Hare, & Connolly, 1987; Munro et al., 2007; Raine, 1993; Syndulko, Parker, Jens, Maltzman, & Ziskind, 1975). A recent meta-analysis aggregating studies on P3b measures and psychopathy revealed a significant moderate correlation between P3b and psychopathic traits in oddball tasks, suggesting some attention and information-processing deficits in these individuals (Gao & Raine, 2009). Therefore, we hypothesized in the current study that unsuccessful psychopaths would show reduced P3b amplitude and longer latency compared to normal controls. To our knowledge, only one prior study has examined novelty P3 in any psychopathic population. Using an auditory three-stimulus oddball task, Kiehl et al. (2006) found that in one sub-sample, novelty P3 amplitudes were significantly smaller for caught psychopaths compared to caught nonpsychopaths at midline sites, although the findings were not replicated in another sub-sample. In sum, there is some evidence that unsuccessful psychopaths are characterized by P3b and novelty P3 deficits.

There has been virtually no research on successful psychopaths who escape detection by the criminal justice system. Preliminary evidence has suggested that successful and unsuccessful psychopaths may be etiologically distinct population, and that the observed neurobiological deficits may be specific to the unsuccessful psychopaths. In the first experimental study on successful and unsuccessful psychopaths, Ishikawa, Raine, Lencz, Bihle, and LaCasse, 2001 found *reduced* heart rate stress reactivity and impaired executive functioning (Wisconsin Card Sorting Task) in unsuccessful psychopaths. In contrast, successful psychopaths showed *heightened* stress reactivity and significantly *outperformed* nonpsychopathic controls on executive functioning. These findings suggest that enhanced autonomic responding and better executive functioning may protect a sub-group of psychopaths from being detected and arrested, allowing them to perpetrate significant harm to others in the community. Based on these findings, we hypothesized that impaired information processing, as indexed by abnormal P3 amplitude and latency, may be found in unsuccessful psychopaths. In contrast, successful psychopaths may be characterized by enhanced information processing (increased P3 amplitude and shorter P3 latency) which

may give rise to their being more sensitive to environmental cues predicting detection and capture, and in turn be a compensatory factor that helps them escape long-term incarceration.

Although research on psychopathy has focused on neurobiological processes, a few studies have implicated childhood maltreatment as a psychosocial factor predisposing some individuals to psychopathy in incarcerated populations (Campbell, Porter, & Santor, 2004; Koivisto & Haapasalo, 1996; Marshall & Cooke, 1999; Patrick, Zempolich, & Levenson, 1997). For example, Marshall and Cooke (1999) found that male prison psychopaths compared to non-psychopathic prisoners were more likely to have negative home backgrounds (e. g., abuse, neglect, poor supervision) as assessed in an open-ended interview. The association between childhood maltreatment and psychopathic traits has also been found in community population (Lang, af Klinteberg, & Alm, 2002; Weiler & Widom, 1996). In a 20-year follow-up study, those children abused and neglected before age 11 years had higher scores in adulthood on the Psychopathy Checklist – Revised (PCL-R) (Weiler & Widom, 1996). Similarly, in a longitudinal study of males and females, children who suffered child abuse were more likely to show a psychopathic personality at age 28 years (Gao, Raine, Chen, Venables, & Mednick, 2010). Overall, this small literature on family factors is beginning to identify physical maltreatment as a significant correlate of psychopathy. No study has assessed physical abuse by a caregiver in successful and unsuccessful psychopaths, and given prior work on unsuccessful, caught psychopaths, it is hypothesized that childhood abuse will be a characteristic of unsuccessful psychopaths in particular.

Following on from our prior study (Ishikawa et al., 2001), psychopathic traits were assessed among a new community male sample at risk for psychopathy using the PCL-R (Hare, 2003). P3 amplitudes and latencies were recorded during an auditory three-stimulus oddball task, while self-report physical abuse was assessed using the Conflict Tactic Scale (CTS; Straus, 1979). P3 measures and physical abuse data were compared between the successful psychopaths, unsuccessful psychopaths, and nonpsychopathic controls. It is hypothesized that in comparison to the controls (1) unsuccessful psychopaths would show P3b and novelty P3 deficits; (2) successful psychopaths would in contrast show enhanced cognitive performance as indexed by larger P3 amplitude and shorter P3 latency; and (3) unsuccessful psychopaths would be characterized by significant childhood physical abuse. No definitive hypotheses on the differences between the two subtypes of psychopaths were formed, given the limited knowledge on this subject, but these issues were explored in the current study.

Methods

Participants

One hundred and twenty-one males (mean age = 35.84, $SD = 8.30$, range = 23 to 56 years) were recruited from temporary employment agencies in the greater Los Angeles area, and represents a different sample to that used in our prior work (Ishikawa et al., 2001; Raine et al., 2004; Yang et al., 2005). Participants were informed of the nature of the study and of its potential risks and benefits. After giving written informed consent, participants were individually assessed for two days. All participants were paid \$15/hour for participation. The study and all its procedures were approved by the university's institutional review board. IQ scores were created by prorating four subscales of the WAIS-III (Similarities, Arithmetic, Digit Symbol and Picture Completion).

Psychopathy Assessment

Psychopathy was assessed using the PCL-R: 2nd Edition (Hare, 2003), and supplemented by 10 sources of collateral data. The PCL-R: 2nd Edition consists of 20 items and reflects two factors: interpersonal/affective characteristics (e. g., glibness/superficial charm, pathological lying, shallow affect) and antisocial behavior (e. g., impulsivity, need for stimulation/proneness to boredom, juvenile delinquency; Hare, 2003). Ratings were made by a clinical neuroscience Ph.D-level research assistant (the third author 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 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).

Expanding on our prior work on community assessment with the PCL-R (Ishikawa et al., 2001), we met the challenge of using the PCL-R in a community sample by further developing a systematic and comprehensive protocol for the collation of 10 sources of objective collateral data derived from professional web-based background check services. These data not only provided new additional background information for item evaluation (e.g., irresponsibility, proneness to boredom, criminal versatility), but also allowed for assessment of inconsistencies and conflicts between the participant's oral report and objective data reports that aid assessment of pathological lying and deception. The ten collateral data sources were as follows: (1) the Interpersonal Measure of Psychopathy (IM-P; Kosson, Steuwerwald, Forth, & Kirkhart, 1997), which provides an interviewer's ratings of an individual's psychopathic interpersonal behaviors, has demonstrated construct validity with the PCL-R in a prison sample, and has been validated for use with nonincarcerated samples (i.e., college students; Kosson et al., 1997); (2) self-reported theft, drug offenses, and violent crime as assessed by an adult extension (Raine, Lencz, Bihle, LaCasse, & Colletti, 2000) of the National Youth Survey self-report delinquency measure (Elliott, Ageton, Huizinga, Knowles, & Canter, 1983); (3) official state-level Department of Justice criminal records for California; (4) nationwide state-level criminal and court record database searches; (5) federal criminal records database search; (6) involvement in civil action, liens, and other financial judgments; (7) personal history judgments including marriage and divorce, prior residences and relocations, relatives, and significant others; (8) data derived from, and behavioral observations made during, the Structured Clinical Interview for DSM-IV Axis I Disorders (SCID-I; First, Spitzer, Gibbon, & Williams, 1997); (9) the SCID Axis II Personality Disorders (SCID-II; First, Gibbon, Spitzer, Williams, & Benjamin, 1997). The SCID-I and II diagnoses were made by the same research assistant trained on the SCID (Ventura, Liberman, Green, Shaner, & Mintz, 1998); and (10) independent IM-P ratings made by two different laboratory assistants during separate phases of testing throughout the two days.

Group classification was conducted in three steps following procedures used in our prior studies (Ishikawa et al., 2001; Raine et al., 2004; Yang et al., 2005). First, a tertile split on the PCL-R score was performed, and those falling in the top and bottom third were retained ($n = 85$), with the middle third excluded. This tertile split resulted in a cut-off point of 23 (i.e., participants with total PCL-R scores equal to or larger than 23 were grouped as psychopaths). This is consistent with the cut-off point used in our prior work among a completely different community sample. Although it is lower than the commonly used cut-off point of 30 in incarcerated population (Hare, 2003), we used this cut-off point both to be consistent with our prior research, and also because the PCL-R (which was developed on prison samples) underestimates psychopathy scores in community samples which do not have access to the rich sources of collateral information obtained in institutionalized samples. Second, among those scoring ≥ 23 on the PCL-R, participants were separated

according to whether they had ever been convicted of a crime ($n = 23$ (51%) “successful psychopaths” and $n = 22$ (49%) “unsuccessful psychopaths”); conviction data were derived from court records and self-reported criminal convictions. Finally, only those without a history of criminal conviction were retained in the bottom third of the PCL-R to delineate a group of nonpsychopathic controls ($n = 30$).

Psychophysiological Measures

A three-stimulus oddball task—Psychophysiological data were collected while the participants were seated in a temperature-controlled, light- and sound-attenuated psychophysiological recording laboratory, with a computer screen placed in front of the participant at a distance of 1 meter. They were presented with a series of high- and low-pitched tones, at 75 dB and lasting for 150 ms, with an inter-stimulus interval of 1.0 s. The rise and fall times of the tones were 5 ms. Participants were instructed to press a response button as quickly as possible with their dominant hand in response to the low-pitched tones (“target”, presented at 500 Hz), but not to the high-pitched tones (“nontarget”, presented at 1000 Hz). In addition to the 35 targets and 280 nontarget tones, 35 novel/irrelevant tones (e.g. bell, bird, honk), were also presented. The target, nontarget, and novel tones were presented in random order. Before the actual test, participants were given 6 practice trials to ensure that they could distinguish between the high- and low-pitched tones. Participants were asked to keep their eyes fixated on an X on the computer screen in the entire session. The duration of the auditory oddball task was 7.5 mins.

Psychophysiological recording and quantification—EEG data were recorded from 32 scalp sites and the left and right mastoids using a lycra Electro-Cap (Eaton, OH) based on the 10-20 system, using the James Long Inc. amplification system (Caroga Lake, NY). An anterior midline site (AFz) served as the ground electrode and the vertex (Cz) as reference site. EEG data was re-referenced offline to an average mastoids configuration. Recording sites were prepared by gently abrading each site with a conductive abrasive. Impedances were kept below 10 K Ω with the large majority of impedances being less than 5 K Ω . The scalp EEG was amplified by a factor of 5000 with a sampling rate of 512 Hz. The hardware filter settings for the EEG channels were 0.1-Hz high pass and 100-Hz low pass. One bipolar electrooculogram (EOG) channel was recorded from two silver-silver chloride electrodes placed above and below the supra- and infra-orbital ridges of the left eye using the same bandpass settings. Automated regression-based algorithms were used to minimize blink artifacts in the EEG (Lins, Picton, Berg, & Scherg, 1993) and epochs confounded by eye or body movements were manually identified and excluded. On average, about 20% of the trials in each condition were excluded.

P3 amplitude and latency were measured at two electrode sites at frontal (Fz for novelty P3) and parietal midline (Pz for P3b) locations. Peak amplitude was measured relative to the prestimulus baseline (i.e. 100 ms prior to the stimulus onset), and latency was calculated as the interval between the onset of the stimulus and the peak response. P3 was defined as the largest positive-going wave in the range of 200-500 ms after the stimulus onset.

Childhood Maltreatment

Experience of significant physical childhood abuse was assessed using a modification (Widom & Shepard, 1996) of the CTS (Straus, 1979). A limitation of some retrospective accounts of child abuse is that they have not been validated against prospectively collected official reports of childhood victimization. One exception is a self-report interview measure based on a modification of the CTS, which is validated against adults who had been physically abused 20 years previously as demonstrated by official court reports of child abuse, and has been shown to demonstrate good discriminant and predictive validity

(Widom & Shepard, 1996). Abuse was restricted to acts occurring before the end of elementary school because it is thought that early trauma may be of particular importance in influencing behavioral development (Teicher, Ito, Glod, & Andersen, 1997) and changes in brain structure (Teicher, Samson, Sheu, Polcari, McGreenery, in press). A total score of very severe physical abuse was computed to assess severity of physical abuse (Straus & Gelles, 1990).

Statistical Analyses

Repeated measures analysis of variance (ANOVA) were conducted with psychopathy groups (successful psychopaths, unsuccessful psychopaths, and controls) as a between-subjects factor, stimulus condition (novel vs. nontarget) as a within-subject factor for novelty P3 at Fz, and stimulus condition (target vs. nontarget) as a within-subject factor for target P3b measures at Pz. Separate analyses were conducted for P3 amplitude and latency. Paired-sample *t*-tests were conducted to test the a priori hypotheses with respect to the P3 and abuse differences between successful psychopaths, unsuccessful psychopaths, and nonpsychopathic controls. Cohen's *d* (Cohen, 1988) was used to calculate effect sizes. Chi-square analyses were carried out when study variables were highly skewed. Finally, logistic regression was conducted to examine the prediction of group membership using P3 measures and childhood abuse data.

Results

Demographic Information

The final sample included 18 Caucasians, 35 African Americans, 15 Latinos, 3 Asian American/Pacific Islanders, and 4 others. The three groups did not differ on ethnicity, $\chi^2(8) = 12.97, p = .11$, marital status, $\chi^2(2) = 1.97, p = .37$, history of alcohol use, $\chi^2(2) = 1.03, p = .60$, and IQ scores, $F(2, 72) = 0.93, p = .39$. However, the three groups differed on age, $F(2, 72) = 3.854, p < .05$, with successful psychopaths being younger than the unsuccessful psychopaths, $p < .05, d = 0.80$. Groups also differed on education level (years in school), $F(2, 72) = 12.04, p < .05$, with controls showing higher education than both successful psychopaths, $p < .05, d = 0.62$, and unsuccessful psychopaths, $p < .001, d = 1.45$, while the successful psychopaths showed a trend towards higher education than the unsuccessful psychopaths, $p = .07, d = 0.79$. See Table 1 for means and cell counts for the three groups. Finally, childhood abuse was not correlated with P3 measures, $F < 1, p > .05$.

P3 Measures and Psychopathy

Novelty P3 at Fz—Means and standard deviations for P3 measures for each group are displayed in Table 2. For amplitude, a significant main effect of Condition was found, $F(1, 72) = 91.46, p < .001$, with P3 amplitudes elicited by the novel stimuli significantly higher than those by the nontarget stimuli ($d = 1.30$). Neither the main effect of Group nor the Condition $\times$ Group interaction was significant, $F(2, 72) < 1.06, p > .35$.

Similarly, a significant main effect of Condition was found for P3 latency, $F(1, 72) = 8.52, p < .01$, with novel stimuli eliciting longer latency than the nontarget, $d = 0.38$. The main effect of Group was not significant, $F(2, 72) = 0.60, p = .55$. However, a significant Condition $\times$ Group interaction was found, $F(2, 72) = 4.38, p < .05$.

As seen in Figure 1, controls showed a shorter P3 latency to the novel stimuli as opposed to the nontarget stimuli, whereas successful psychopaths showed a reversal of this pattern. Specifically, paired sample *t*-tests revealed that successful psychopaths showed a significantly longer P3 latency to the novel than to the nontarget stimuli, $t(22) = 4.77, p < .001, d = 1.23$. No such effect was found in controls, $t(29) = 0.47, p = .64$, although

unsuccessful psychopaths showed a trend indicating increased P3 latency to novel relative to the nontarget stimuli, $t(21) = 1.82$, $p = .084$, $d = 0.65$.

P3b at Pz—For amplitude, the main effect of Condition was significant, $F(1, 72) = 203.68$, $p < .001$, indicating larger P3 amplitude to the target than to the nontarget, $d = 2.08$. The main effect of Group was also significant, $F(2, 72) = 3.43$, $p < .05$. Post hoc comparisons with Bonferroni correction revealed a trend for smaller P3 amplitudes in unsuccessful psychopaths in comparison to the successful psychopaths ($p = .05$, $d = 0.69$) and controls ($p = .10$, $d = 0.63$), while the successful psychopaths and controls did not differ, $p = 1.00$.

The Condition $\times$ Group interaction was marginally significant, $F(2, 72) = 2.62$, $p = .08$. Exploring this trend further, in comparison to the controls, successful psychopaths showed larger P3 amplitudes to the nontarget, $t(51) = -2.22$, $p < .05$, but not to the target, $t(51) = 0.17$, $p = .86$. Unsuccessful psychopaths, in contrast, showed smaller P3 amplitude to the targets, $t(50) = -2.03$, $p < .05$, but not to the nontarget, $t(50) = 0.70$, $p = .49$, relative to the controls.

For latency, the main effect of Condition was significant, $F(1, 72) = 54.45$, $p < .001$, indicating longer latency to the target stimuli than to the nontarget, $d = 1.13$. Neither the main effect of Group nor the Condition $\times$ Group interaction was significant ($p > .25$) (see Fig. 2).

Childhood Maltreatment and Psychopathy

Abuse data were highly skewed (skewness = 6.28), and therefore they were dichotomized according to the CTS very severe violence = 0 (“absent” group) or > 0 (“present” group). Cell counts are given in Table 2. Chi-square tests showed that compared to the control group, significantly more unsuccessful psychopaths experienced childhood abuse, $\chi^2(1) = 4.40$, $p < .05$. No group differences were found between successful and unsuccessful psychopaths or between successful psychopaths and controls ($p > .23$).

Since groups differed on age, education level, and childhood abuse, the above analyses on P3 were repeated with these three variables as covariates. All the group effects remained unchanged.

Prediction of Group Membership

Logistic regression using the stepwise Wald method was conducted using P3 and childhood maltreatment measure. When successful psychopaths were compared with controls, the frontal P3 latency to the nontarget alone predicted 14.1% of the variance in group membership with an accuracy of 60.8%. Similarly, in predicting whether a person would belong to the unsuccessful psychopaths or controls, the combination of P3 amplitude elicited by the target at Pz and maltreatment accounted for 26.8% of the variance with a classification accuracy of 67.3%.

Discussion

The main findings of the current study were that compared to nonpsychopathic controls, unsuccessful psychopaths had reduced P3b amplitudes to the target stimuli at Pz, whereas successful psychopaths showed shorter frontal P3 latency and larger parietal P3 amplitude to the nontarget stimuli. In addition, unsuccessful but not successful, psychopaths had experienced significant childhood physical abuse by a caregiver than the nonpsychopathic controls. This constitutes the first study examining electrophysiological characteristics and

significant physical child abuse among successful and unsuccessful psychopaths, with findings suggesting potentially distinct etiologies underlying these two subgroups of psychopaths.

Consistent with our hypotheses, unsuccessful psychopaths showed reduced P3b amplitudes to the targets compared to the controls, replicating findings from caught, incarcerated, criminal psychopaths (Kiehl et al., 2006; Kiehl et al., 1999). Furthermore, these effects were not accounted for by the group differences on age, education level, or childhood maltreatment experience. This finding supports the idea that psychopathy is characterized by an inability or deficiency in sustaining attention or appropriately allocating attentional resources to task demands (Cleckley, 1941; Kosson & Newman, 1986). Since the LC-NE system is involved in P3b generation (Nieuwenhuis et al., 2005), it is plausible that deficits in LC-NE system may give rise to impaired bottom-up control that normally helps promote memory operations, in turn predisposing to psychopathic behavior among unsuccessful psychopaths. How exactly this gives rise to specific features of psychopathy remains to be elucidated. Alternatively, it is also possible that psychosocial environmental factors, including mild or moderate head injuries, may contribute to the reduced attention focus capacity and impaired P3b in these individuals (e.g., Segalowitz, Bernstein, & Lawson, 2001).

Although successful psychopaths did not show an enhanced P3 to target and novel stimuli, they exhibited significantly shorter frontal P3 latencies and larger parietal amplitudes to the nontarget, irrelevant stimuli. P3 latency has been considered to reflect an individual's capability to retain recently encoded information for comparison with new incoming information (Polich, Howards, & Starr, 1983), although it is unknown what the psychological correlates are that underlie P3 latency to nontarget stimuli. If shorter P3 latency in general indexes faster information processing and better information storage capability, then successful psychopaths may benefit from the enhanced capacity for retaining information about the environment. Similarly, the amplitude of the P3 has been related to a wide range of cognitive processes, and is considered an index of the allocation of neural resources and cognitive processing capability, with increasing amplitude reflecting an increasing degree to which the stimulus is processed (Polich, 2003). In the oddball task, the P3 to intervening nontarget stimuli may be related to response inhibition capability (Polich, 2007), and the larger amplitude and shorter latency across regions in successful psychopaths may therefore indicate an enhanced frontoparietal system in this subgroup. The frontoparietal system which consists of the lateral prefrontal cortex, anterior cingulate cortex, and inferior parietal lobule, has been identified in fMRI research as supporting cognitive control and decision-making processing (Vincent, Kahn, Snyder, Raichle, & Buckner, 2008). This enhancement in the frontoparietal system, in addition to other evidence of neurobiological advantages (including heightened stress reactivity, better executive functioning, and absence of the prefrontal structural impairment; Ishikawa et al., 2001; Raine et al., 2004; Yang et al., 2005), may constitute a constellation of compensatory factors that mitigates against detection and conviction in this subgroup of successful psychopaths. Future studies employing source analyses (e.g., LORETA) are needed to test this hypothesis on enhanced frontoparietal functioning in successful psychopaths.

Unsuccessful, but not the successful, psychopaths are more likely to have been physically abused by a caregiver at an early age than the nonpsychopathic controls, whereas the differences between the two psychopathic groups were not significant. Placing this psychosocial finding in the context of prior psychophysiological, neuropsychological, and brain imaging evidence differentiating the successful and unsuccessful psychopaths (Ishikawa et al., 2001; Raine et al., 2004; Yang et al., 2005), it is suggested that these two subtypes of psychopaths may have distinct etiologies with different biological correlates but

that psychosocial differences between the subtypes are less pronounced. This bears some general similarity to the dual-process model of psychopathy (Patrick, 2007), which assumes that the two main dimensions of psychopathy reflect distinct etiologies, and that some individuals with elevation on one dimension but not the other show different patterns of relations with other external criteria, including psychophysiological and cognitive functioning. The current findings of social adversity and P3 deficits in unsuccessful psychopaths, in conjunction with prior brain and neurocognitive deficits observed in other samples of unsuccessful psychopaths, highlight the heterogeneity of psychopathy and the need for more refined sub-group analyses in future studies.

Several limitations of the study should be noted. First, sample sizes for the three groups are relatively small and Type II error is possible and larger sample size may produce more significant findings. At the same time, sample sizes are almost twice as large as those in our prior work on successful and unsuccessful psychopaths. Nevertheless, findings of the current study are consistent with prior findings in successful psychopaths of enhanced neurocognitive, affective, and structural prefrontal characteristics in contrast to impairments in these domains in unsuccessful psychopaths. In addition, the effect sizes reported in the current study are modest to large. A second limitation is that only male participants were included, therefore it is unknown whether these findings can be generalized to female psychopaths. Third, findings may or may not generalize to high-functioning “white collar” psychopaths in industry and commerce, although findings provide a model for future work on successful psychopaths in business, politics, and other professions.

Despite these limitations, the current study extends our prior work using an independent sample and provides initial support for the hypothesis that successful psychopaths and unsuccessful psychopaths showed different psychophysiological information-processing as indexed by P3 measures in a three-stimulus oddball paradigm and psychosocial adversities including childhood physical abuse. Findings support the perspective that successful and unsuccessful psychopaths may have distinct etiologies based on psychosocial and neurocognitive risk factors. Future studies need to differentiate subgroups of psychopaths when examining the neurobiology of psychopathy. Ultimately, it is hoped in the long term that this new knowledge may shed light on the early prevention of psychopathy by diverting individuals with psychopathic personality away from antisocial behaviors and toward more prosocial outlets by enhancing their neurocognitive functions. In one longitudinal study, better nutrition, more physical exercise, and cognitive stimulation from ages 3 to 5 years was shown to produce long-term psychophysiological changes 6 years later at age 11 years, including increased skin conductance level, increased orienting, and a more aroused and mature EEG profile at rest and during cognitive challenge (Raine, Mellingen, Liu, Venables, & Mednick, 2003; Raine et al., 2001). Because this environmental enrichment was also found to reduce criminal offending at age 23 years (Raine et al., 2003; Raine et al., 2001), such early prevention programs could in theory help reduce the enhanced antisocial and criminal behavior perpetrated by psychopaths. Nevertheless, an alternative perspective on intervention that needs to be considered is whether such interventions would improve brain functioning in unsuccessful psychopaths and transform them into successful psychopaths who go on to perpetrate antisocial behaviors without detection.

In summary, the present study examined P3 event-related potentials and childhood maltreatment in successful and unsuccessful psychopaths. In comparison to the nonpsychopathic controls, unsuccessful psychopaths are characterized by reduced parietal P3b amplitude and childhood physical abuse, whereas the successful psychopaths showed shorter frontal P3 latency and larger parietal P3 amplitudes to the nontarget stimuli. It is tentatively suggested that the cognitive deficits underlined by impaired LC-NE system may predispose some individuals to psychopathic behavior, whereas enhanced frontoparietal

functioning may protect a subgroup of psychopaths from being detected/convicted for the crimes they perpetrate.

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Figure 1. P3 latency to nontarget and novel stimuli at Fz in controls, successful, and unsuccessful psychopaths.

Figure 2. Grand average ERPs for the three groups elicited by (1) novel stimuli at Fz site (top left), (2) nontarget stimuli at Fz site (bottom left), (3) target stimuli at Pz site (top right), and (4) nontarget stimuli at Pz site (bottom right).

Table 1

Demographic Information for the Three Groups

Demographic Variable	Unsuccessful Psychopaths (n = 22)	Successful Psychopaths (n = 23)	Controls (n = 30)
Ethnicity			
Caucasian	2	5	11
Asian	1	2	0
Latino	3	4	8
African-American	14	12	9
Other	2	0	2
Age (years)	38.77 (9.86)*	31.96 (6.94)	34.97 (7.88)
Education level (years)	12.55 (1.22)	13.83 (1.95)	15.10 (2.16)
Marital status			
Never married	17	21	23
Married at least once	4	2	7
IQ	97.14 (13.92)	98.43 (12.38)	101.00 (18.34)
History of alcohol use			
Yes	7	10	9
No	12	13	21

Note. Standard Deviations are in parentheses.

* $p < .05$.

Table 2

Means (Standard Deviations) for P3 Measures and Maltreatment Data by Group

Measure	Unsuccessful Psychopaths (n = 22)	Successful Psychopaths (n = 23)	Controls (n = 30)
Fz: P3 Amplitude			
Nontarget	2.45 (1.99)	3.12 (2.32)	2.06 (2.15)
Novel	7.39 (6.33)	9.61 (6.62)	9.25 (6.63)
Fz: P3 Latency			
Nontarget	0.26 (0.09)	0.24 (0.07)	0.30 (0.12)
Novel	0.31 (0.06)	0.31 (0.04)	0.29 (0.05)
Pz: P3 Amplitude			
Nontarget	2.04 (1.29)	3.29 (1.91)	2.30 (1.33)
Target	8.70 (5.45)	11.94 (5.58)	12.20 (5.36)
Pz: P3 Latency			
Nontarget	0.29 (0.09)	0.25 (0.05)	0.28 (0.09)
Target	0.36 (0.08)	0.36 (0.05)	0.35 (0.05)
Childhood Maltreatment			
Present	8	6	4
Absent	12	16	25