



Relation of frontal N100 to psychopathy-related differences in selective attention[☆]



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ARTICLE INFO

Article history:

Received 20 January 2014

Accepted 20 August 2014

Available online 29 August 2014

Keywords:

Psychopathy
Attention
Interference
ERP
N100

ABSTRACT

Research indicates that psychopathy may be characterized by early attentional abnormalities that undermine the processing of peripheral information during goal-directed activity (Baskin-Sommers & Newman, 2012). Past work has found that psychopathic individuals show reduced interference on the Box Stroop task, in which color names are spatially separated from (i.e., peripheral to) colored stimuli (Hiatt, Schmitt, & Newman, 2004). The present study sought to replicate and extend these findings. A priori predictions were that psychopathy scores would be inversely related to interference and that psychopathy-related differences in Box Stroop conflict processing would emerge at an early stage as measured by event-related potentials (ERP). Results supported both hypotheses. Moreover, the association between the early attention-related component (N100) and interference was moderated by level of psychopathy. These findings suggest that psychopathic individuals have less coordinated responses to conflict than healthy individuals, a conjecture that has implications for information integration and self-regulation.

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1. Introduction

Psychopathy is a personality disorder characterized by a collection of emotional, interpersonal, and behavioral features that include shallow affect, egocentricity, exploitation, lack of remorse, and impulsivity, as well as antisocial conduct (American Psychiatric Association, 2000; Hare, 1996). Although they represent only 15–20% of criminal offenders (Glenn & Raine, 2008), psychopathic offenders commit a disproportionate percentage of crimes (Harris, Skilling, & Rice, 2001) and have high rates of violent recidivism (Viding, 2004). Given the social and financial costs of their crime (Hare, 2006; Hare & Neumann, 2009; Reid, 1998), it is imperative to clarify the psychobiological processes responsible for psychopathic offenders' failures to manage their behavior.

One perspective suggests that psychobiological abnormalities in information processing underlie psychopathy's association with chronic antisociality and self-regulatory deficits. More specifically, research indicates that psychopathy is characterized by abnormalities in selective attention, such that psychopaths fail

to allocate attention to potentially important peripheral stimuli while engaged in goal-directed activity. Baskin-Sommers, Curtin, and Newman (2011) propose that these abnormalities reflect an early attention bottleneck that limits the processing of information unrelated to their mental set (see Baskin-Sommers & Newman, 2012; Leber & Egeth, 2006).

The early stages of information processing involve the simultaneous processing of sensory elements; these sensory representations are only available for retrieval for a short length of time. When an organism is engaged in goal-directed behavior, the first stage of processing is influenced by the behavioral relevance of stimuli. Zylberberg, Dehaene, Mindlin, and Sigman (2009) postulate, “the ‘memory’ of a stimulus resides in the decaying trace of a stimulus transient response” (p. 13). Memory representations that are not selected for higher-level processing in working memory quickly fade. For psychopathic individuals, the establishment of an information-processing bottleneck may guide attention to stimuli consistent with the mental set and consequently preclude the elaborated processing of information that is inconsistent with or peripheral to goal-related focus (Baskin-Sommers, Curtin, Li, & Newman, 2012; Baskin-Sommers et al., 2011). Consequently, this peripheral information may remain “pre-conscious”, or perceived but not consciously processed due to inattention (Dehaene & Changeux, 2011). As a result, representations of peripheral information may not be strong enough to modulate ongoing goal-directed behavior.

[☆] This work was supported by grant 5R21DA030876 from NIDA. Special thanks to Deputy Warden Tom Nickel, Dr. Kevin Kallas, and many others at the Department of Corrections for their support of this research.

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In fact, across experimental contexts psychopathic offenders display a pattern of selective attention, such that they fail to process peripheral information when their attention is already engaged in a goal-directed task. For instance, when non-psychopathic control participants engage in tasks involving low perceptual load (i.e., there are few distracter stimuli), they are more likely to experience distracter interference (Lavie & Tsai, 1994). However, the same distractors elicit less interference in psychopathic individuals (Sadeh & Verona, 2008). Moreover, psychopathic individuals display significantly less behavioral interference than controls when engaged in tasks containing incongruent contextual cues (see Newman, Brinkley, Lorenz, Hiatt, & MacCoon, 2007; Newman, Schmitt, & Voss, 1997; Zeier, Maxwell, & Newman, 2009). A handful of electrophysiological studies support the proposal that psychopathic individuals show reduced responses to contextual cues when these cues are not directly related to their goal-directed focus of attention. Moreover, they provide evidence for the early nature of these attentional abnormalities. Event-related potentials (ERPs) provide a high-resolution, temporally precise look at the earliest changes in visual processing associated with visual-spatial selective attention (Herrmann & Knight, 2001; Hillyard & Anillo-Vento, 1998). Jutai and Hare (1983) found that psychopathy was associated with reduced N100 amplitudes to task irrelevant tone pips while engaged in a selective attention task. Baskin-Sommers et al. (2012) demonstrated that psychopathic individuals were able to effectively ignore threat-related distractors (as indexed by larger P140) when they were peripheral versus central to their goal-directed behavior. The temporal nature of these waveforms is consistent with the notion that psychopathy is characterized by abnormalities early in the processing stream. The fact that they were modulated by attentional focus further supports the proposition that psychopathy is associated with anomalous early selective attention.

One paradigm that is well suited to examine abnormal processing of contextual cues is the “Box Stroop” task (Hiatt, Schmitt, & Newman, 2004). During this task, color names (green, red, blue, or yellow) are displayed in black ink and are surrounded by a green, red, blue, or yellow box. Participants are told to say the color of the box. Like the standard Stroop effect, congruent word name and box color typically facilitate color naming, while incongruent stimuli generally cause interference. The Box Stroop, however, provides a clearer test of psychopaths’ early selective attention compared to the standard paradigm because incongruent information (i.e., the word names) is spatially separated from, and thus peripheral to, the predominant focus of attention (i.e., the box color). Specifically, the spatial division enables the sensory amplification and early selection of attended-to-be-processed features (Hillyard, Vogel, & Luck, 1998). Accordingly, individuals high in psychopathy display normal interference in the traditional Stroop task, yet they exhibit significantly less interference on the Box Stroop than controls (Hiatt et al., 2004). This finding is consistent with the proposition that psychopathy is associated with abnormal attention processes. Thus, the Box Stroop represents a validated paradigm that yields psychopathy-related effects with conflict-laden stimuli. However, to date, there is no direct substantiation linking performance on this task to early attentional processes.

The goal of the current study is threefold. On the behavioral level, the current research seeks to replicate and extend Hiatt et al.’s (2004) findings of attentional abnormalities in psychopathic individuals. Specifically, we hypothesize that there will be a significant effect for psychopathy such that individuals high in psychopathy will show less interference than individuals with lower psychopathy scores (i.e., the difference between the time it takes for individuals high in psychopathy to respond to an incongruent trial compared to a neutral trial will be significantly less than for nonpsychopathic individuals).

The second goal of the study is to clarify the temporal profile of the hypothesized information processing abnormality. Specifically, we were interested in locating an ERP window that might be interpreted as a feed-forward processes related to early selective attention (i.e., within 200 ms of stimulus onset; Lamme & Roelfsema, 2000). Although past research is consistent with our proposal that the spatial separation of box and word stimuli enables early selection in psychopathic individuals, the behavioral evidence revealing reduced interference alone cannot specify the early versus late onset of psychopathy-related differences in performance. In this study, we use ERPs to explore the temporal dynamics of psychopathy-related effects in the Box Stroop. We predict that the ERPs to incongruent versus neutral stimuli in psychopathic individuals will differ from those in non-psychopathic individuals, and that these differences will be evident early in the information-processing stream.

The final goal of the study is to explore psychopathy-related differences in the association between ERP and interference data to determine whether the relationship between ERP amplitude and interference varies as a function of psychopathy. In light of postulated abnormalities in early selective attention, we predict that the association between behavior and ERP data will differ for high versus low psychopathic participants. This finding would support the idea that psychopathy is typified by abnormalities in early attention responses to goal-incongruent information.

2. Methods

2.1. Participants

Participants consisted of 117 Caucasian male inmates ages 18–45 ($M = 30.44$, $SD = 6.70$) from a medium-security prison in central Wisconsin. To be included in the study, participants had to be between 18 and 45 years old, free of history of psychosis or bipolar disorder, not currently taking psychotropic medication, and have an IQ score of 70 or greater. Individuals meeting the inclusion criteria were invited to participate in an ongoing study. All participants provided written informed consent according to procedures approved by the University of Wisconsin – Madison Human Subjects Committee. On the first day of the study, inmates were called to a private office and completed a semi-structured life history interview with an experienced interviewer. This interview included questions on childhood, education, and occupational, interpersonal, and legal histories. Following the interview, the interviewer reviewed the institutional file in order to corroborate information provided during the interview. The combination of interview and file information was used to rate psychopathy according to Hare’s (2003) Psychopathy Checklist-Revised (PCL-R). Four participants were excluded from analyses due to less than 90% accuracy on the experimental task.

2.2. Psychopathy Checklist-Revised (PCL-R)

We assessed psychopathy using Hare’s (2003) Psychopathy Checklist-Revised (PCL-R). The PCL-R consists of 20 items that are rated according to the degree to which a characteristic is present (significantly = 2, moderately = 1, not at all = 0). In the present sample, scores on this measure ranged from 5 to 36, with a mean of 23.14 ($SD = 6.86$). Interrater reliability (intraclass correlation) for PCL-R total score, based on six dual ratings, was .98.

2.3. Materials

2.3.1. Stimuli

Stimuli were 120 color words (*red, blue, green, or yellow*, written in black font) or neutral stimuli (string of the letter *i*) presented on a white background surrounded by a colored rectangular frame (*red, blue, green, or yellow*). The frames measured 2.3 by 3.2 cm. Word and neutral stimuli were presented centrally in the frames.

2.4. Experimental task

The task consisted of 40 practice trials and 120 experimental trials. For the first 20 practice trials, color words (*red, blue, green, or yellow*) written in black font were presented centrally on the computer screen and participants were instructed to read the words. For the remaining 20 practice trials, colored rectangular frames were presented on the screen and participants were instructed to name the color of the frame (*red, blue, green, or yellow*). Each experimental trial consisted of a simultaneously presented color word or neutral stimulus enclosed by a colored rectangular frame. Participants were told to name the color of the frame while ignoring all other information. There were a total of 40 congruent trials (color word matched the frame

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