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# Information Processing of the Rorschach's Traumatic Content Index in Trauma-exposed Adults: An Event Related Potential (ERP) Study

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ABSTRACT

PTSD elicits hypervigilance to trauma-related stimuli. Our novel research examined event-related potentials from Blood, Anatomy, and Morbid content derived from the Rorschach's traumatic content index (TCI). Participants included: 16 with PTSD, 24 trauma-exposed without PTSD (non-PTSD), and 16 non-traumatized Controls. P3 oddball paradigms were used with TCI-derived Distractors and neutral Targets/Standards. We predicted larger P3 amplitudes in the context of TCI-related Distractors among trauma-exposed participants. Significant interaction of Group and Distractor type was found for P3 amplitude. PTSD and non-PTSD groups exhibited larger P3 amplitudes from Blood and Anatomy Distractors, and attenuated amplitudes from Morbid; the reverse pattern was found among Controls. A late negative component was observed, denoting a significantly larger area under the curve (AUC) among the PTSD group for Anatomy and Blood Distractors. Larger AUC's were observed for Distractors among the PTSD group, and Targets among Controls. The findings concur with the neurocircuitry model of PTSD and suggest impairment in cerebral suppression of attention to stimuli that may have been perceptually primed with trauma.

## 1. Introduction

An exposure to a life-threatening event is sometimes followed by an elevation of psychological distress due to the development of such symptoms as intrusive memories, hyper-arousal, and avoidance of trauma-related stimuli. These post-traumatic stress (PTS) symptoms are usually followed by a feeling of constant threat to the individual's well-being (Ehlers & Clark, 2000) and the perception of the environment as unstable and dangerous (Janoff-Bulman, 1989). In some cases, severe PTS symptom prevalence beyond one month may lead to the clinical diagnosis of a post-traumatic stress disorder (PTSD) (DSM-5, American Psychiatric Association, 2013).

### 1.1. ERP studies in PTSD

Event-related potential (ERP) studies have been used to compare information-processing patterns of individuals diagnosed with PTSD to healthy controls (Felmingham, Bryant, Kendall, & Gordon, 2002; Galletly, Clarc, McFarlane, & Weber, 2001; McFarlane, Weber, & Clark, 1993). Among several ERP components, the P3, a centro-parietal positive component occurring around 300 ms after stimulus onset, has been widely used to examine trauma-related changes in attention (for review, see Javanbakht, Liberzon, Amirsadri, Gjini, & Boutros, 2011; Johnson, Allana, Medlin, Harris, & Karl, 2013). The P3 is commonly elicited by a three-stimuli oddball paradigm, in which the participants are requested to respond to a low frequency target stimulus presented amongst high frequency, repetitive standard stimuli and low frequency salient distractors they must ignore; the stimuli are referred to as Target, Standard, and Distractor stimuli. It has been previously reported that when individuals with PTSD are presented with an oddball paradigm that includes trauma-related Distractors, the P3 amplitude in response to Targets and Distractors (also known as P3b and P3a, respectively) is enhanced, while in the context of neutral (not trauma-related) Distractors, the response to either Target and Distractor stimuli is reduced (Karl, Malta, & Maercker, 2006; Javanbakht et al., 2011; Johnson et al., 2013). PTS symptom severity has also been associated with P3 amplitudes (Lobo et al., 2015). These findings suggest that, compared to healthy controls, individuals diagnosed with PTSD exhibit attentional alterations: allocating more attention to stimuli perceived to be threatening or trauma-related, while reducing attention to neutral

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stimuli (Johnson et al., 2013; Karl et al., 2006). This pattern of cerebral response was conceptualized at the cognitive level by the “resource allocation” model of PTSD (Ehlers & Clark, 2000). According to this model, trauma facilitates the development of a “fear network”, leading to an attentional bias to trauma-related stimuli at the expense of neutral stimuli. These assertions also align with the “neurocircuitry” model of PTSD that associates PTSD-related information processing changes and interaction patterns of cerebral structures (Rauch, Shin, Whalen, & Pitman, 1998). According to this neurocognitive model, PTSD involves impaired prefrontal cortex (PFC) top-down regulation of hyper-responsivity within the amygdala, along with alterations in hippocampal activity that lead to deficits in contextual conditioning (Rauch, Shin, & Phelps, 2006). PFC deficit, particularly in the ventral/medial PFC, which is thought to impair suppression of attention to trauma-related stimuli, might be expressed by larger P3 amplitudes to trauma-related stimuli. Both models are supported by the clinical manifestation of PTSD that includes hypervigilance to trauma-related stimuli, exaggerated startle response and concentration difficulties (DSM-5, APA, 2013). Additionally, although most studies have reported on significant P3 differences between participants diagnosed with PTSD and either non-PTSD traumatized participants or Control subjects with no previous traumatic history (Johnson et al., 2013), recent research findings suggest that P3 alterations might be found among individuals with previous traumatic exposure even without meeting clinical criteria for PTSD diagnosis (Kimble, Fleming, Bandy, & Zambetti, 2010).

Most conceptualizations of PTSD characterize the condition as hyper-responsivity to incoming stimuli that has been coupled with traumatic experience. However, the nature of these associations and the mechanism by which some inputs become “trauma-related stimuli” is still not clear. Previous research findings suggest that those with PTSD exhibit elevated cerebral responses to stimuli that are associated with their specific traumatic experience, such as combat- or earthquake-related stimuli, but not to trauma-irrelevant stimuli (Attias, Bliech, Furman, & Zinger, 1996a; Attias, Bliech, & Gilat, 1996b; Stanford, Vasterling, Mathias, Constans, & Houston, 2001; Zhang, Kong, Han, Najam Ul Hasan, & Chen, 2014; Zhang, Kong, Hasan, Jackson, & Chen, 2015). Other authors have hypothesized that cognitive alterations related to PTSD are not limited to increased attention to specific trauma-associated stimuli but to a general increased expectancy of threat, resulting in elevated sensitivity to threat-related cues (Engelhard, de Jong, van den Hout, & van Overveld, 2009; Kimble et al., 2010). Though some research suggests that PTSD-related hypersensitivity to threat exists even at earlier, subliminal levels, this attentional bias to threat was postulated to mainly occur in later, post-recognition stages of information processing (Buckley, Blanchard, & Neill, 2000). The hypothesis of general sensitivity to threat is also supported by the expression of PTSD symptoms that frequently include a constant search for a wide variety of threats in the everyday environment, beyond those related to the original trauma. However, ERP studies that have used threatening stimuli not directly related to the participants' traumatic experiences have found reduced threat processing, possibly due to an increased expectancy of threatening information or, alternatively, as an adaptive response aimed at reducing emotional arousal (Kimble, Batterink, Marks, Ross, & Fleming, 2012; MacNamara, Post, Kennedy, Rabinak, & Phan, 2013).

Some previous research, however, suggest that those with PTSD may possess a general sensitivity that is not limited to perceived threat. Research findings demonstrating greater PTSD-related cerebral responses to unpleasant/negative stimuli (not considered threatening or trauma-related) have caused some authors to suggest the existence of a PTSD-related hypervigilant pattern of information processing; such a pattern, they suggest, is characterized by an elevated response to negative emotional stimuli, regardless whether or whether not it contains threatening content (Blomhoff, Reinvang, & Malt, 1998; Lobo et al., 2014, Saar-Ashkenazy et al., 2015). However, valence effects were also found in ERP studies among participants with no trauma history, and have been associated with selective attention to negative stimuli; this has been postulated to represent a general “negativity bias” among the general population (Olofsson, Nordin, Sequeira, & Polich, 2008). Therefore, it is not clear whether this increase in cerebral response to negative stimuli can be attributed solely to PTSD.

A common denominator of previous hypotheses is that patients with PTSD may be hypervigilant to the conceptual aspects of threatening stimuli, in which association with the traumatic event is achieved via meaning (for example, when a rape victim encounters the word “helplessness”). An alternative approach suggests that trauma-exposed participants may be highly responsive to the perceptual properties of stimuli (Ehlers et al., 2002), in which an association between stimuli and the traumatic event is made through perceptual priming (for example, seeing headlights leads to accelerated heart rate because they were previously encountered during a nighttime head-on collision). The perceptual priming approach postulates that the traumatic experience leads to data-driven processing (i.e. focusing on the perceptual and sensory impression of an event rather than on its meaning). This results in a strong perceptual priming of the various stimuli encountered in temporal proximity to the traumatic experience (Christianson, 1992; Halligan, Clark, & Ehlers, 2002; Kindt, van den Hout, Arntz, & Drost, 2008; Van der Kolk & van der Hart, 1989; Wing Lun, 2008). These primed stimuli, when identified in the everyday environment, are then perceived as a warning signal of impending danger and may lead to a rapid, vivid recollection of the traumatic event, experienced as a “flashbacks.” This approach is supported by behavioral research studies which indicate that, in comparison to the general population, traumatized individuals who develop PTSD symptoms are more likely to associate stimuli characterized by salient perceptual properties with trauma-related information (Halligan et al., 2002; Kindt et al., 2008; Lin, Hofmann, Qian, & Li, 2015). Accordingly, war veterans with PTSD have been found to demonstrate heightened physiologic arousal, expressed by higher skin conductance and elevated heart rate, when perceiving Rorschach Inkblots as being related to autobiographical images of combat trauma. The authors postulated that this heightened physiologic arousal to the Rorschach inkblots corresponds to the development of intrusive symptoms that occur when encountering a stimulus with perceptual similarity to those encountered at the time of trauma (Goldfinger, Amdur, & Liberson, 1998). Since the Rorschach is considered primarily a perception test (Blatt, 1990), this finding suggests that perceptual properties of inkblots may trigger a conditioned response mediated by altered information processing patterns.

In summary, current cognitive and neurocircuitry models suggest that PTSD involves directing more attention to stimuli that were previously associated with traumatic experience. This was believed by some authors to reflect a deficit in PFC top-down regulation of hyper-reactivity within the amygdala to trauma-related stimuli (Rauch, Shin, et al., 1998, Rauch, Shin, & Phelps, 2006). ERP research demonstrating larger P3 amplitudes to trauma-related stimuli among individuals with PTSD supports this theory. While some authors have suggested that the association between incoming stimuli and traumatic experience is achieved via meaning (through direct association with a specific traumatic experience) or via other conceptual properties of the stimuli (level of threat or level of negativity), others have suggested that the association of stimuli with the traumatic event is made through perceptual priming.

### 1.2. The Rorschach inkblot test and PTSD

The Rorschach is a psychological test intended for evaluation of perception along with cognitive function and personality characteristics (Blatt, 1990; Exner, 2001). The Rorschach examines the individual's perception of 10 inkblots printed on cards, and is widely used by clinical psychologists for assessment and intervention planning (Weiner & Greene, 2007). Exner (1974) developed a comprehensive system for analyzing responses to the Rorschach test, currently the most frequently used method