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Brain Research

Research Report

Pedophilic brain potential responses to adult erotic stimuli

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ARTICLE INFO

Article history:
Accepted 2 December 2015
Available online 9 December 2015

Keywords:
Pedophiles
Cognition
Erotic stimuli
Event-related potentials

ABSTRACT

Cognitive mechanisms associated with the relative lack of sexual interest in adults by pedophiles are poorly understood and may benefit from investigations examining how the brain processes adult erotic stimuli. The current study used event-related brain potentials (ERP) to investigate the time course of the explicit processing of erotic, emotional, and neutral pictures in 22 pedophilic patients and 22 healthy controls. Consistent with previous studies, early latency anterior ERP components were highly selective for erotic pictures. Although the ERPs elicited by emotional stimuli were similar in patients and controls, an early frontal positive (P2) component starting as early as 185 ms was significantly attenuated and slow to onset in pedophilia, and correlated with a clinical measure of cognitive distortions. Failure of rapid attentional capture by erotic stimuli suggests a relative reduction in early processing in pedophilic patients which may be associated with relatively diminished sexual interest in adults.

1. Introduction

The pressing need for effective research in sexual offenses committed by people with pedophilia against children is highlighted by the psychological and emotional cost to many victims and their families, the financial cost of incarceration of offenders, and the relative reduced efficacy of treatment interventions for pedophiles (Furby et al., 1989; Hanson et al., 1993; Seto, 2009). The understanding of pedophilia and the development of successful treatments require an elucidation of the cognitive processes underlying the initiation and maintenance of sexual offending behavior directed at pre-pubescent children. This would include the study of cognitive operations at all stages of the offense chain with multiple

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http://dx.doi.org/10.1016/j.brainres.2015.12.004
0006-8993/

behavioral and brain-based functional measurement methodologies embedded in paradigms of modern cognitive science.

Recent brain imaging investigations have attempted to identify the neural correlates of sexual arousal in healthy, non-patient samples. Most frequently evidenced with functional magnetic resonance imaging (fMRI) of blood-oxygenation-level dependent (BOLD) signals, the presentation of preferred erotic (vs. emotional) pictorial stimuli has been associated with the activation of a broad network of cortical and subcortical regions implicated both in sexual arousal and emotional processing (Hanman et al., 2008; Kuhn and Gallinat, 2011; Poeppl et al., 2014; Stoléru et al., 2012; Walter et al., 2006, 2008).

Functional imaging has produced heterogeneous findings regarding neural markers of pedophilia and have shown considerable overlap in brain function between pedophiles and teleiophiles (people who are sexually attracted to adults) during sexual arousal processing (Mohnke et al., 2014; Tenbergen et al., 2015). fMRI studies have shown a relatively comparable pattern of neural activity in persons with pedophilia and in healthy, non-pedophilic individuals during visual stimulation with pictures for the respective erotic conditions (Wiebking and Northoff, 2013). Employing control methodologies that equate the valance (unpleasant-to-pleasant) and arousal (low-to-high) of visual non-erotic emotional and erotic stimuli, functional neuroimaging in pedophiles has shown increased amygdala responsiveness to non-explicit pictures of children (vs. adults) which, in controls, resulted in less responsiveness than adult pictures (Sartorius et al., 2008). In men with sexual attraction to boys, increased activation of subcortical regions (thalamus, globus pallidus, striatum) was seen while viewing sexually arousing pictures with homosexual content (Schiffer et al., 2008a), and while the brain network response (comprising the occipitotemporal and prefrontal cortex) of men with sexual attraction to girls to hetero-pedophilic stimuli was similar to that of heterosexual controls to heterosexual stimuli, only the pedophiles with sexual attraction to girls showed hyper-activation of prefrontal brain regions (dorsolateral [DLPFC], dorsomedial [DMPFC] prefrontal cortex and right orbitofrontal cortex [OFC]) in response to pictures of children (Habermeyer et al., 2013; Poeppl et al., 2011; Schiffer et al., 2008b). These studies highlighting the importance of prefrontal cortex in the sexual processing of pedophilic stimuli parallel a recent study showing that pedophiles and teleiophiles very accurately (95%) can be separated based on preference-specific brain activity in a distributed set of brain areas associated with the processing of sexual stimuli, and include frontal brain regions such as the cingulate cortex and insula (Ponseti et al., 2012). Furthermore, there is recent evidence that sexual orientation might be inferred from stimulus-dependent prefrontal activity, including the motor cortex (Schecklmann et al., 2015).

In the neurophenomenological model of sexual arousal (Redoute et al., 2000; Stoléru et al., 1999), activation of different brain regions during sexual stimulation is associated with intertwining psychological subprocesses, including a physiological, motivational, emotional and cognitive component. In addition to the motor imagery of potential sexual behavior, the cognitive component includes the evaluation of stimuli as sexually incentive (mediated by activity of the right lateral OFC and inferior temporal gyrus) and the focus of attention on these stimuli (superior and inferior parietal lobule). Although the spatial resolution of fMRI and other neuroimaging strategies is ideal for elucidating which neural structures are implicated in aberrant sexual processing in people with pedophilia (Ponseti et al., 2012), the response time (>1–2 s) of these methodologies makes them less able to index cognitive processes governing the early phases of the sexual response, such as those involving perceptual and attentional mechanisms, matching of stimuli with memory elements, and response preparation (Janssen et al., 2000). Sexual stimuli have been shown to undergo parallel processing, with some being performed rapidly (automatic processing) and without conscious awareness, and perhaps triggering physiological arousal (Childress et al., 2008). In contrast, other processing which triggers subjective sexual arousal is carried out more slowly and with full conscious appraisal (Spiering et al., 2003).

Electroencephalographically (EEG) derived event-related potentials (ERP) may contribute to our knowledge of how the human brain processes sexually arousing pedophilic stimuli. Their superior temporal resolution (1 ms) allows for the probing and characterization of both early (<200 ms), pre-perceptual processes and later, effortful and attention-dependent, higher order cognitive operations that are elicited in response to stimuli with emotional content. The majority of affective ERP studies have employed standardized stimuli from the International Affective Picture System (IAPS), which have been rated with respect to their valence category and arousal level (Lang et al., 2001). The primary affective dimensions of valence and arousal have been found to influence ERP components at several processing stages that occur at separate and overlapping latencies (Olofsson et al., 2008). Findings of valence effects, although inconsistently reported, are seen at several latency ranges, mainly with respect to relatively short latency (100–300 ms) ERP components, that appear to be associated with rapid selective attention processes. The more consistently observed ERP effects of pictorial arousal modulation have been linked to automatic attention with middle-range latency (200–300 ms) components, while intrinsically motivating stimuli facilitate processing for subsequent memory storage at longer (>300 ms) latencies.

Appearing as early as 150 ms after the picture onset, emotional (vs neutral) stimuli also enhance short latency ERP components reflecting earlier stages of attentional processing. This is most commonly evidenced by increases in both the early posterior (occipital) negativity or EPN (Foti et al., 2009; Franken et al., 2009) and the early anterior (frontal) positivity or EAP (Taake et al., 2009; Asmaro et al., 2012; Feng et al., 2012a, 2012b), suggesting that motivationally salient emotional stimuli undergo biased processing in the form of a rapid, pre-attentive response.

Most robust are ERP findings with the sustained (~400–2000 ms), late positive potential (LPP), which peaks at 500–700 ms over posterior (parietal) scalp regions and increases in amplitude to positive and negative emotionally valenced stimuli (Schupp et al., 2006; Codispoti et al., 2007; Hajcak et al., 2008). Consistent with a two-stage model of emotional