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Pain thresholds, pain-induced frontal alpha activity and pain-related evoked potentials are associated with antisocial behavior and aggressiveness in athletes

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ABSTRACT

Objectives: Deficiencies in perceptual and cognitive functions have been linked with antisocial and aggressive behavior. To test whether these putative relationships generalize to sport – a context where such behavior is common – we determined the extent to which pain thresholds and cortical activity in response to painful electrical stimulation were associated with antisocial and aggressive behavior in sport; we also examined their link to moral disengagement.
Design: A cross-sectional design was used.
Method: Ninety-four participants completed questionnaires, had their pain threshold determined, and then had their central and frontal pain-related cortical activity recorded while they were electrically stimulated at supra-threshold intensity.
Results: Subjective pain thresholds were positively related while pain induced frontal alpha power was negatively related to antisocial behavior and aggressiveness. Central pain evoked potential amplitudes were negatively related to aggressiveness and moral disengagement.
Conclusions: Sensitivity to and cortical processing of noxious stimuli were reduced in individuals who more frequently behave antisocially and aggressively when playing sport and who are more likely to use psychosocial maneuvers to justify their harmful behavior. Our findings reveal that pain-related deficits are a feature of individuals who engage in more frequent antisocial and aggressive behavior in the context of sport.

1. Introduction

Sport is a social context where moral issues are highly relevant (for reviews see Kavussanu, 2008, 2012). Research has shown that during competitive games, team sport players deliberately foul, physically intimidate, and try to injure their opponents (e.g., Kavussanu, Seal, & Phillips, 2006; Kavussanu, Stamp, Slade, & Ring, 2009). Thus, it is important to improve understanding the factors associated with antisocial and aggressive behavior, which encompasses acts intended to harm or disadvantage another individual (Kavussanu, 2012) and harm another individual (Anderson & Bushman, 2002), respectively. Although much research has examined antisocial and aggressive behavior in sport from a social psychological perspective, more recently researchers have begun to investigate this important topic from a *cognitive neuroscience* perspective (e.g., Kavussanu, Willoughby, & Ring, 2012; Micai, Kavussanu, & Ring, 2015). Research in non-sport contexts has revealed differences in how the brains of antisocial and aggressive individuals respond to sensory and cognitive demands compared to other individuals (for reviews see Blair, 2001; Volavka, 1990, 1999). For instance, these reviews discuss evidence that violent individuals are characterized by structural and functional abnormalities in their frontal and temporal lobes. We aimed to extend these findings to the sport context. In team sports that involve physical contact between players, such as association football, basketball, field hockey, and rugby, antisocial and aggressive behaviors are relatively common occurrences during games (Bredemeier & Shields, 1986; Kavussanu, 2012). Accordingly, the current study determined whether abnormal cortical processing and perception of pain is a feature of individuals who engage more frequently in antisocial and aggressive behavior when playing competitive team sport.

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1.1. Pain sensitivity

Antisocial behavior and emotional detachment are the two key defining features of psychopathy (Blair, 2001). Early clinical observations noted that psychopaths often fail to avoid punishment (Cleckley, 1959; Hetherington & Klinger, 1964). Experimental research has since documented that psychopaths are characterized by impaired aversive conditioning (Flor, Birbaumer, Hermann, Ziegler, & Patrick, 2002; Hare & Quinn, 1971; Lykken, 1957), blunted conditioned anticipatory arousal prior to an impending noxious stimulus (Hare, 1965), reduced blink responses to noxious stimuli (Benning, Patrick, & Iacono, 2005; Patrick, Bradley, & Lang, 1993), and reduced pain sensitivity (Fedora & Reddon, 1993; Hare, 1968; Hare & Thorvaldson, 1970; Schalling, 1971; Schalling & Levander, 1964). Taken together, these data suggest that the increased frequency of antisocial behavior in psychopaths may be linked to their relative insensitivity to aversive stimuli.

Further support for this proposal comes from studies showing that pain sensitivity is lower in aggressive and violent individuals (Niel, Hunnicut-Ferguson, Reidy, Martinez, & Zeichner, 2007; Reidy, Dimmick, MacDonald, & Zeichner, 2009; Seguin, Pihl, Boulerice, Tremblay, & Harden, 1996). Seguin et al. (1996) reported that boys with higher pain tolerance to pressure stimulation were characterized by increased history of physical aggression based on teacher reports. Niel et al. (2007) used the response choice aggression paradigm and found that males with higher pain tolerance to electrical stimulation administered higher intensity shocks and more maximal intensity shocks to their opponents. Similarly, Reidy et al. (2009) found that male (but not female) participants with higher pain tolerances scored higher on self-reported measures of verbal and physical aggression. Although the mechanism underlying this pain-aggression phenomenon has yet to be identified, a number of candidates have been mooted. It has been suggested that pain tolerant individuals may underestimate the degree of pain inflicted on their victims or may have been toughened up by frequent fights (Sequin et al., 1996). Based on this evidence, we tested the possibility that relative insensitivity to pain may be a feature of athletes who engage more frequently in antisocial and aggressive behavior when playing sport. In team contact sports, physical contact during competitive games can lead to unpleasant sensory and emotional experiences associated with tissue damage (i.e. pain). Antisocial behavior and aggression in team contact sports might be linked with pain sensitivity for various reasons: Pain tolerant athletes may be more likely to commit physical antisocial and aggressive acts because they cannot empathize with their victims (Stanger, Kavussanu, & Ring, 2012; Stanger, Kavussanu, Willoughby, & Ring, 2012) because of impaired cognitive perspective taking or emotional empathic concern and personal distress (cf. Sequin et al., 1996).

1.2. Pain-related evoked potentials

Researchers (e.g., Bromm & Lorenz, 1998) often supplement subjective reports of pain with its objective neurophysiological correlates to paint a more complete picture of the psychological and physiological processes implicated in the perception and processing of noxious stimuli. However, to our knowledge, no study has assessed cortical evoked potentials to painful stimuli to explore the central processes underlying the antisocial behavior–pain relationship. The electroencephalogram (EEG) represents a means of assessing cortical activity that involves the recording of electrical activity on the scalp to detect voltages generated inside the brain. Evoked potentials represent the cortical activity elicited in response to the presentation of an exteroceptive stimulus, such as a painful electrical stimulus. The most commonly studied pain-related evoked potentials are the N2 and P2 potentials, which refer to the second negative and positive peaks, respectively, of the cortical response to a noxious stimulus and represent the cortical activity that results from processing a painful stimulus (Treede, Kenshalo, Gracely, & Jones, 1999). These scalp potentials are measured at the vertex because they are reliably found to be largest in amplitude at this location. Pain-related evoked potentials reflect pain processing, that is increasingly painful stimuli elicit increasingly larger potentials (Bromm & Lorenz, 1998). It is possible that attenuated pain-related evoked potentials are associated with the tendency to commit antisocial and aggressive acts.

1.3. Frontal cortical activity

There is evidence to suggest that frontal dysfunction, assessed using EEG, is a feature of aggressive individuals (Volavka, 1990). For instance, one study noted that violent behavior in psychiatric patients was negatively correlated with frontal alpha band EEG activity, particularly resting activity in the left hemisphere (Convit, Czobor, & Volavka, 1991). Similarly, brain imaging studies have implicated reduced prefrontal cortical activity (Raine, Buchsbaum, & LaCasse, 1997) and frontal lesions (Damasio, Grabowski, Frank, Galaburda, & Damasio, 1994; Grafman et al., 1996) with antisocial and aggressive behavior. These observations are compatible with the proposal that aggressive behavior is determined by a circuit in the brain comprising the orbitofrontal cortex, anterior cingulate, and amygdala (Davidson, Putnam, & Larson, 2000). In EEG studies, prefrontal cortical activity is typically indexed by the amount of activity in the alpha frequency band: A fast Fourier transform is applied to the raw EEG waveform to yield the spectral power of the EEG signal with a frequency of between 8 and 12 cycles per second. High alpha activity was originally interpreted as cortical idling (Pfurtscheller, Stancak, & Neuper, 1996), but more recently has been viewed as reflecting a sensory gating mechanism involving inhibition of task-irrelevant and activation of task-relevant areas (Jensen & Mazaheri, 2010; Schurmann & Basar, 2001). Although it is possible to assess frontal alpha brain activity under resting conditions, recent research has found better results using stimulus induced activity (e.g., Coan, Allen, & McKnight, 2006). Taken together, there is sufficient evidence to suggest that relatively attenuated pain-induced frontal brain activity may be associated with the tendency to behave antisocially in sport.

1.4. Moral disengagement

Moral disengagement refers to the psychosocial mechanisms people use to minimize negative affect when they engage in transgressive behavior (Bandura, 1991; Boardley & Kavussanu, 2011). It allows individuals to engage in conduct that violates their personal standards without experiencing intense negative emotions that usually accompany such behavior. Moral disengagement operates by mentally reconstruing harmful behaviors into benign acts, minimizing personal accountability for harmful behavior, misrepresenting the injurious effects that result from such behavior, and blaming the nature or actions of the victim. Previous research has found that players who have the propensity to morally disengage are more likely to report engaging in antisocial behaviors toward other players (Boardley & Kavussanu, 2011). Given the link between blunted emotion and antisocial