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Emotional reactivity and force control: The influence of behavioral inhibition

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ABSTRACT

Individual difference measures have been shown to alter emotional arousal and emotional arousal alters force production during force control tasks. In the current study we examined whether individual differences in behavioral inhibition influence force control during emotional image viewing. Subjects who scored high and low in behavioral inhibition (BIS) produced force with visual feedback for 5 s. Feedback was then removed and replaced by a mutilation, attack, erotica, or neutral image for 6 s. The magnitude and direction of error in force production during image presentation was compared between groups and across image type. The high BIS group displayed a relative increase in force production during exposure to attack and mutilation images compared to the low BIS group. Bias scores (i.e., comparison of unpleasant image to neutral or pleasant image) further confirmed these findings by demonstrating a relative increase in force for the high BIS group during attack and mutilation images as compared to erotica images, whereas the low BIS group displayed the reverse effect. Together these findings extend the premise of action readiness to demonstrate that dispositional differences in behavioral inhibition interact with emotional state to alter force production.

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1. Introduction

One subcomponent of emotional expression is action readiness (Frijda, 1986, 2009). Emotion driven changes in action readiness have been demonstrated across a range of tasks using a range of different experimental approaches. Behavioral and neurophysiological studies have shown that viewing emotional stimuli leads to changes in excitability of the corticospinal motor tract (Coombes, Tandonnet et al., 2009; Hajcak et al., 2007), the initiation and execution of approach and avoidance arm movements (Chen & Bargh, 1999; Rotteveel & Phaf, 2004), the amplitude, accuracy, and variability of force control (Coombes, Cauraugh, & Janelle, 2006, 2007a, 2007b; Coombes, Gamble, Cauraugh, & Janelle, 2008; Coombes, Janelle, & Duley, 2005), and changes in posture and the initiation of gait (Hillman, Rosengren, & Smith, 2004: Naugle, Joyner, Coombes, Hass, & Janelle, accepted for publication). Related work has demonstrated links between subclinical depression and a reduction in force amplitude following transcranial magnetic stimulation (Oathes & Ray, 2006), and clinical bipolar depression and the steadiness and velocity scaling of force production (Lohr & Caligiuri, 2006). The DSM-IV diagnostic criteria for major depression include agitation and psychomotor retardation which present clinically as a reduction in speed, a delay in motor initiation, body immobility, and postural abnormalities. Rates of agitation and psychomotor retardation in depressed individuals ranges from 46% to 67% (Sobin & Sackeim, 1997). In addition to the co-morbid motor abnormalities in depression, atypical balance and motor functions have been reported among individuals with high trait anxiety (Coombes, Higgins, Gamble, Cauraugh, & Janelle, 2009; Wada, Sunaga, & Nagai, 2001), phobic/panic symptoms (Yardley, Britton, & Lear, 1995), and obsessive compulsive disorder (Leocani, Locatelli, & Bellodi, 2001). While it is clear that individual differences and experimentally induced emotional states independently influence the motor system, it is not fully understood how these factors interact to influence voluntary motor control. All previous work which has integrated emotion and motor control has either implemented a between group design to examine force control in depression (Lohr & Caligiuri, 2006; Oathes & Ray, 2006), or has used a within-subject design to examine how experimentally induced emotional states alter motor system activity (Chen & Bargh, 1999; Coombes et al., 2008; Hajcak et al., 2007). The objective of the current paper was to examine how behavioral inhibition interacts with emotional state to influence one's ability to control force production.

1.1. Behavioral inhibition system (BIS)

Reinforcement Sensitivity Theory (RST) postulates the existence of three major systems of emotional responding: the behavioral inhibition system (BIS), the behavioral activation system (BAS), and the fight/flight/freeze system (FFFS) (Gray, 1970, 1982; Gray & McNaughton, 2000). BIS is hypothesized to regulate affect and behavior in response to signals of punishment, non-reward, and novel stimuli, whereas BAS directs behavior in response to appetitive and rewarding cues. Individuals high in BIS sensitivity are characterized by worry proneness and anxious rumination, which ultimately lead to a constant vigilance for danger and a high susceptibility for anxiety disorders (Corr & McNaughton, 2008). Founded on Gray's BIS and BAS framework, Carver and White (1994) developed the first valid and reliable self-report measures (BIS/BAS scales) of sensitivity to BIS and BAS activation. The BIS and BAS scales primarily focus on affective consequences (i.e., *how a subject would feel* in response to various situations), and have consistently supported the existence of Gray's two orthogonal systems (e.g., Gomez & Gomez, 2002). Given that the BIS scale has been robustly implicated in affective disorders the focus of the current study was on behavioral inhibition.

Greater relative BIS activation coincides with exposure to conditioned and unconditioned aversive stimuli, leading to increased negative valence of the aversive stimuli as well as heightened arousal and attention, anxiety, passive avoidance, and the inhibition of behavior that may result in painful or negative consequences (Gray, 1994). Comparatively higher scores on the BIS scale have been associated with negative affect and self-reported anxiety (Buickians, Miklowitz, & Kim, 2007; Segarra et al., 2007) and the processing of unpleasant information such as during exposure to blood and disgust images (Caseras et al., 2006; Gomez & Gomez, 2002). BIS activation also correlates with greater right posterior temporal and parietal cortical activity (Hewig, Hagemann, Seifert, Naumann, & Bartussek,