



Sensitivity of Gray's Behavioral Inhibition System in clinically anxious and non-anxious children and adolescents

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ABSTRACT

The child version of the Carver and White (1994) BIS/BAS-scales (Muris et al., 2005) was used to assess sensitivity of the Behavioral Inhibition and the Behavioral Activation System in clinically anxious and non-anxious youth ($n = 175$, ages 8–18 years, 70 boys). Results supported the hypothesis that clinical anxiety is associated with overactivity in the BIS (Gray, 1982). Consistent with the revised Reinforcement Sensitivity Theory (Gray & McNaughton, 2000) the BIS-scale consists of two subscales, one measuring BIS_Anxiety and one measuring FFFS_Fear. BIS-scores were higher in the anxious sample than in the non-anxious sample. BAS-scores were equal. Higher levels of BIS-activity were related with an increase in symptoms of anxiety and depression. BIS-scores were higher in girls than in boys, there were no gender differences in BAS-scores.

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1. Introduction

Gray's Reinforcement Sensitivity Theory (RST; 1982) postulates how behavior follows from activity in two major brain systems: the Behavioral Approach (BAS) and the Behavioral Inhibition System (BIS). Both systems function independently from one another and are sensitive to different types of reinforcement. The BIS constitutes sensitivity to punishment and conditioned aversive stimuli, the BAS involves responsiveness to reward and other appetitive stimuli. Activity in both systems is related with different emotional and behavioral consequences. BIS-activity leads to feelings of anxiety and initiates behavioral inhibition. BAS-activity is linked with positive feelings and triggers approach behavior.

In addition to its involvement in normal behavior, activity in both systems is thought to underlie different types of psychopathology (e.g., Gray, 1982; Kimbrel, 2008; Quay, 1988). Overactivity of the BIS is assumed to be a vulnerability factor for internalizing problems. Underactivity of the BIS and overactivity of the BAS (or a combination) are thought to be risk factors for externalizing problems. Empirical studies provide evidence for the association of BIS and BAS with various psychopathological symptoms in adults (for review, Bijttebier, Beck, Claes, & Vandereycken, 2009). For example, overactivity in the BAS is found to be associated with

Attention Deficit Hyperactivity Disorder and psychopathy (e.g., Mitchell & Nelson-Gray, 2006; Uzieblo, Verschueren, & Crombez, 2007), while high BIS is associated with symptoms of anxiety and depression (e.g., Kimbrel, Nelson-Gray, & Mitchell, 2007). Research on the role of BIS/BAS-sensitivity in youth psychopathology is based on work by Quay (1988, 1997) who developed a theoretical framework for internalizing and externalizing behavior in children, based on Gray's model. Consistent with the assumptions in adult psychopathology research, Quay linked childhood emotional and behavioral problems to inadequate activation of the BIS, the BAS or both systems. Evidence for the role of BIS and BAS in childhood psychopathology is provided by studies using performance based measures as indices of BIS/BAS-activity. For example, overactivity of the BAS in children with conduct disorder and comorbid ADHD is found in studies using reward contingency tasks (e.g., Matthys, Van Goozen, De Vries, Cohen-Kettenis, & Van Engeland, 1998). Evidence for increased BIS-activity in clinically anxious children has been found using an anxiety-specific version of the stop task (Vervoort et al., submitted for publication).

Several studies used parental rating scales to explore the role of BIS and BAS in internalizing and externalizing behavior in community samples of non-selected children and adolescents (Blair, 2003; Colder & O'Connor, 2004). Studies with self-report questionnaires show that children can provide valid indices for BIS/BAS-sensitivity (e.g., Muris et al., 2005; Slobodskaya, Knyazev, Saffronova, & Wilson, 2003). The BIS/BAS-scales by Carver and White (1994) are

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the most extensively used self-report BIS/BAS-measures. The original questionnaire, developed for adults, contained 20 items and 4 scales: a BIS-scale (with 7 items, e.g., “I worry about making mistakes”) and three BAS-scales. When the original adult version of the BIS/BAS-scales was administered to a community sample of children between 6 and 14 years, meaningful relations between BIS/BAS-scores and symptoms of anxiety and depression have been found (Coplan, Wilson, Frohlick, & Zelenski, 2006). Although this suggests that the adult version of the BIS/BAS-scales can be used with young participants, Muris et al. (2005) developed an age downward version of the questionnaire. Factor analysis showed that this child version contained two factors: one for BIS-sensitivity and one for BAS-sensitivity. In community samples, BIS-scores were positively correlated with Neuroticism and negatively with Extraversion. BAS-scores were positively related to both Neuroticism and Extraversion. High BIS-scores were associated with more emotional problems, whereas high BAS-scores were related with more externalizing problems (Bjørnebekk, 2009; Muris et al., 2005; Sportel, Nauta, de Hullu, Hartman, & de Jong, in preparation).

Despite the relevance of the BIS/BAS-model for childhood psychopathology, there are no studies validating the Carver and White (1994) BIS/BAS-scales in clinical youth samples. Although studies in community samples suggest that extreme BIS/BAS-scores are risk factors for psychological disorders (Sportel et al., in preparation), knowledge of BIS/BAS-profiles in youth who already have developed psychopathology is still limited. Therefore, the current study used the child version of the BIS/BAS-scales (Muris et al., 2005) to compare BIS/BAS-sensitivity between clinically anxious and non-anxious children and adolescents. We expected BIS-scores, but not BAS-scores, in the clinical sample to be higher than in the non-anxious sample. Additionally, we examined associations between BIS/BAS-sensitivity and emotional problems. We expected high BIS-scores to be associated with an increase in emotional symptoms (both anxiety and depression). BAS-scores were expected not to be correlated with anxiety, but to be negatively associated with depression symptoms.

Although the core assumption regarding the relation between BIS and anxiety disorders (i.e. anxiety involves hyperactivity in the BIS) still holds, Gray's original model (1982) has been revised several times. One adaptation involves the relation between BIS and BAS. Gray stated that both systems were independent from one another (i.e. the separable subsystems hypothesis, Pickering, 1997). Since there was only limited support for two orthogonal systems, Corr (2001, 2002) suggested that, under normal conditions, the BIS and BAS might be interdependent and have a joint influence on behavior. Consistent with this so-called joint subsystems hypothesis, BIS and BAS-scores were correlated in community samples of children and adolescents (Bjørnebekk, 2009; Muris et al., 2005). In extreme cases, as in the presence of anxiety disorders, however, Corr expected both systems to act independently as separate systems, since the overactive BIS disproportionately suppresses the influence of the BAS. We will test whether BIS and BAS will jointly predict anxiety symptoms.

Another adaptation to the model (Gray, 1987; Gray & McNaughton, 1996, 2000) relates to its focus on a third system, the Fight-Flight-Freeze System (FFFS), which is activated by conditioned and unconditioned aversive stimuli and initiates escape behavior. Similarly to the proposed involvement of BIS in feelings of anxiety, the FFFS is thought to underlie emotions of fear and panic. While overactivity in the BIS is assumed to be an underlying factor in all anxiety disorders, overactivity in the FFFS is assumed to be related to panic disorder, social phobia and specific phobia (Gray & McNaughton, 2000; Kimbrel, 2008; Zinbarg & Lira Yoon, 2008). Empirical research on this third system is still scarce (Bijttebier et al., 2009), in part because most existing measures to test Gray's theory are based on the original BIS/BAS-model and do not yield

separate scores for BIS and FFFS-sensitivity (Carver & White, 1994; Muris et al., 2005; for exception see Jackson, 2009). However, BIS-items in the Carver and White BIS/BAS-scales might tap both systems (Corr & McNaughton, 2008). Indeed, the BIS-scale seems to incorporate two oblique subscales: BIS-Anxiety (4 items, e.g., “I worry about making mistakes”) and FFFS-Fear (3 items, e.g., “I have few fears compared to my friends”) (Heym, Ferguson, & Lawrence, 2008). We will test whether this two-factor structure can also be extracted from the BIS-scale in our youth sample and we hypothesized that BIS-Anxiety would be associated with all anxiety disorder symptoms, whereas FFFS-Fear would be mostly associated with symptoms of panic disorder and social phobia.

2. Method

2.1. Participants

Participants were 175 children and adolescents (aged 8–18 years old, $M = 13.11$, $SD = 2.53$). Sixty participants (20 boys), recruited in a secondary school in a Dutch urban region, were included in the control group (CON) if no (sub-)clinical internalizing problems were reported by the parents on the Child Behavior Checklist ($T < 65$; which corresponds to the bottom 93% of the general population; Achenbach & Rescorla, 2001; Verhulst & van der Ende, 2001) and if they had no treatment history.

One hundred and fifteen anxiety disordered children and adolescents (50 boys) were included in the clinically anxious group (ANX). All were referred to one of two outpatient child psychiatric units in the Netherlands (de Bascule, Amsterdam and Accare, Groningen). Anxiety diagnoses according to the DSM-IV-criteria were based on a semi-structured diagnostic interview, the Anxiety Disorders Interview Schedule for DSM-IV – Child and Parent Version (ADIS-IV:C/P, Siebelink & Treffers, 2001; Silverman & Albano, 1996). Based on parent and child interviews, a clinical diagnosis with clinician severity rating (CSR, ranging between 1 and 8) was provided. Children were included in the ANX-group when the CSR was 4 or higher (indicative for clinical anxiety diagnosis) on at least one anxiety disorder. Primary diagnoses included Social Phobia (SP, 33.3%), Separation Anxiety Disorder (SAD, 13.9%), Specific Phobia (20.4%), Generalized Anxiety Disorder (GAD, 22.2%) and Panic Disorder with or without Agoraphobia (PD, 10.2%). There was considerable anxiety comorbidity: 68.4% of the anxious participants received two or more anxiety diagnoses (75.7%), an additional mood disorder diagnosis (18.6%), or a comorbid ADHD diagnosis (5.7%). All participants were free of anxiolytic medication and they had not received cognitive behavioral therapy for their anxiety disorder in the last 6 months prior to inclusion in the study. Before treatment, children and parents were asked to participate in a study on mediators and moderators of CBT for anxiety. Participants filled out the questionnaires during a 1-h individual test session, in the presence of one experimenter leader. After this test session, participants in the ANX-group received CBT.

The study design was approved by the medical ethics committee of both participating clinics. Written informed consent was obtained from both children (aged 12 and older, $n = 108$) and their parents.

2.2. Questionnaires

2.2.1. BIS/BAS-scales

Sensitivity of the Behavioral Inhibition and the Behavioral Activation System was indexed by the child version of Carver and White (1994) BIS/BAS-scales (Muris et al., 2005). Twenty items are scored on a 4-point scale (0 = not true, 1 = somewhat true, 2 = true, 3 = very true). Seven items make up the BIS-scale and in-

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