The behavioral inhibition system in childhood and adolescent anxiety: an analysis from the information processing perspective

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Although Gray's BIS-concept is widely used in both adult and child psychopathology research (for review, see Bijebeir et al., 2009), there exists no agreed upon measurement procedure to assess its sensitivity and activity level. Several questionnaires have been used to assess vulnerability to BIS-activating stimuli (i.e. BIS-sensitivity) (for a recent review, see Torrubia, Avila, & Caseras, 2008). Questionnaires, however, might not be optimal to study BIS-activity because they do not measure BIS-activity per se: they only measure the behavioral responses that represent the utmost endpoint of BIS-activity (Smillie, 2008). For example, because it is very unlikely that individuals are consciously aware of the neurological underpinnings of the BIS, it is implausible to assume that they can introspectively report on their BIS-activity. To investigate the neurological workings of the BIS, several neuro- and psychophysiological paradigms (e.g., electrodermal activity, specific EEG-patterns, cortisol levels) are frequently used as indicators for BIS-activity (for reviews, see De Pascalis, 2008 and Smillie, 2008). Additionally, BIS-outputs (behavioral inhibition, stimulus evaluation and selective attention) are more or less automatic responses to the adequate stimuli for anxiety. Being automatic, they are also not accessible for introspection. Assessment techniques other than self-report (i.e. performance-based indirect instruments) must be used to assess the automatic processes that are functional outcomes of BIS-activity (for a complete account of automaticity and indirect measures, see De Houwer, 2006 or Moors & De Houwer, 2006). With respect to measuring the automatic output of BIS-activity (i.e. inhibition, evaluation and attention), the information-processing framework provides several suitable paradigms.

Below, I will describe several questionnaires measuring susceptibility to BIS-inputs (i.e. BIS-sensitivity). In addition to that, I will propose a performance-based paradigm, adopted from information processing research, for the assessment of each of the functional outputs of the BIS: behavioral inhibition, stimulus evaluation and attention (i.e. BIS-activity).

1 Although neuro- and psychophysiological measures are often used indicators for BIS-activity, they are beyond the scope of this dissertation.
QUESTIONNAIRE MEASURES OF BIS-SENSITIVITY

Trait Anxiety or Neuroticism Scales

Because of the strong association between BIS sensitivity and other personality traits like trait anxiety, negative affect and neuroticism, several researchers use questionnaires developed to measure those traits as indices of BIS-sensitivity. Gray himself (1982) suggested that the Manifest Anxiety Scale (Taylor, 1953) was a good measure of BIS-activity. In adult research, for example, the trait-scale of the State-Trait Anxiety Inventory (STAI–T; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983) or the Neuroticism Scale of the Eysenck Personality Questionnaire (EPQ, Eysenck & Eysenck, 1975) are used as BIS-indices (e.g., Gomez & Francis, 2003). In child psychopathology research, for example, the Neuroticism scale of Eysenck & Eysenck's (1975) Junior EPQ or the Shyness Scale of the Early Adolescent Temperament Questionnaire Revised (EATQ-R; Putnam, Ellis, & Rothbart, 2001) are used as an index for BIS-sensitivity (e.g., Dietrich et al., 2009; Séguin, Arseneault, Boulerice, Harden, & Tremblay, 2002).

Despite the strong resemblance between BIS-sensitivity and other personality traits such as trait anxiety, they are not identical. Hence, trait anxiety measures are not optimal BIS-measures. Furthermore, anxiety questionnaires assess anxious behavior rather than sensitivity for the adequate stimuli for anxiety (such as punishment, frustrative nonreward and novelty). Alternatively, several measures directly derived from Gray's Reinforcement Sensitivity Theory (RST) have been developed in the field of adult inhibition research (for a recent review, see Torrubia, Avila & Caseras, 2008). Some of them are used in studies with children or adolescents or have versions adapted for use with youth. Below, I will describe the questionnaires as they are used in child or adolescent samples, with a focus on the BIS-scales within these instruments [see Table 2.1].

RST-based questionnaires

The Gray-Wilson Personality Questionnaire. The Gray-Wilson Personality Questionnaire (GWPG; Wilson, Barrett, & Gray, 1989) is the most extensively used RST-based questionnaire in research with children and adolescents. The questionnaire consists of 6 scales: ‘Approach' and ‘Active Avoidance' [for BAS], ‘Passive Avoidance' and ‘Extinction' [for BIS], ‘Flight' and ‘Fight' [for FFS]. BIS-related items include statements as ‘(I am) easily embarrassed' and ‘(I) stay out of way of people who are angry'. The original
adult questionnaire has been adapted for use with youth samples by removing items that were inappropriate for school-age children (e.g., items that referred to changing jobs or driving a car) (Slobodskaya, Safronova, Knyazev, & Wilson, 2001). Factor analysis of the 96 remaining items revealed two main orthogonal factors. One factor loaded on ‘Passive Avoidance’, ‘Extinction’ and ‘Flight’ and was consistent with Gray’s BIS-dimension. The second factor loaded on the three remaining scales and was consistent with BAS. There are two short forms of the GWPQ, one with 28 items and one with 24 items (GWPQ-28, Slobodskaya, Knyazev, Safronova, & Wilson, 2003; GWPQ-24, Knyazev, Slobodskaya, Karchenko, & Wilson, 2004). Both short forms consist of a BIS and a BAS-scale. The BIS scales were meaningfully related with self-report scales measuring neuroticism (rs between .21 and .35; Knyazev et al., 2004; Knyazev & Slobodskaya, 2003, 2006; Knyazev, Slobodskaya, Sofronova, Sorokin, Goodman, & Wilson, 2003; Knyazev & Wilson, 2004; Slobodskaya et al., 2001; Slobodskaya, Safronova, & Windle, 2005) and trait anxiety (r=.51; Knyazev, Bocharov, Slobodskaya, & Ryabichenko, 2008) and with scales measuring emotional problems (rs between .06 and .47; Knyazev & Wilson, 2004; Slobodskaya, 2007; Slobodskaya et al., 2001, 2003, 2005). In addition to that, children and adolescents with high BIS-levels had more negative and hostile perceptions of happy, angry and neutral faces (Knyazev et al., 2008).

**The Carver & White BIS/BAS-scales.** The BIS/BAS-scales by Carver and White (BIS/BAS-scales, 1994) are the most frequently used RST-scales in adult research. Several versions of the BIS/BAS-scales are used with children and adolescents. A parent-report version of the scales was used to assess BIS and BAS sensitivity in toddlers (aged 3 to 5). BIS was found to be related with fearful temperament (rs between .34 and .37, Blair, 2003; Blair, Peters, & Granger, 2004). When the original self-report scales were administered to adolescents (aged 12 to 16) and adults (aged 21 to 40), the same four-factor structure was found in both age groups: one BIS-scale (with 7 items, e.g., ‘I worry about making mistakes’) and three BAS-scales (‘Drive’, ‘Fun Seeking’ and ‘Reward Responsiveness’) (Cooper, Gomez, & Aucote, 2007). BIS-scores were related with measures of negative affect (r=.41), fear of negative evaluation (r=.48) and social anxiety (r=.27 for social situations in general and r=.42 for new and unfamiliar social situations) in a sample of children (aged 6 to 14) (Coplan, Wilson, Frohlick, & Zelenski, 2006). Although these studies suggested that the original adult version of the BIS/BAS-scales scales can be used in child and adolescent research and that BIS- and BAS-scores from youngsters are comparable to scores from adults, there are different age downward adaptations of the original scales. Recently, two
versions of a self-report child adaptation of the BIS/BAS-scales scales were published. Muris et al. (2005) adapted the original items to make them suitable for use with children from 8 to 12. The BIS/BAS-scales for Children has a two-factor solution with a BIS and a BAS-factor. Field (2006) also simplified the original BIS-scale for use with children under 10. His version correlated very highly \((r=.87)\) with that of Muris et al. (2005). The BIS-factor was related to neuroticism \((rs\ between .62 \ and \ .67; Bjørnebekk, 2009; Muris et al., 2005)\), fearful temperament \((r=.64, Muris, Meesters, van den Hout, Wessels, Franken, & Rassin, 2007)\), negative affect \((r=.44; Bjørnebekk, 2009)\), anxiety and depression symptoms \((rs\ between .50 \ and \ .58 \ and \ r=.29 \ for \ self-report, \ r=.39 \ and \ r=.15 \ for \ parent-report; Field, 2006; Muris et al., 2005)\), social phobia \((r=.70; Sportel, Nauta, de Hullu, de Jong, & Hartman, in preparation)\) and emotional problems \((rs\ between .60 \ and \ .63 \ for \ self-report, \ r=.27 \ for \ parent-report, Muris et al., 2005, 2007)\). Furthermore, high BIS-scores were predictive of an attentional bias towards threat and of behavioral avoidance in an approach task with unknown stimuli that were described as threatening (Field, 2006). BIS-scores also moderated the effect of threatening information on the physiological responses during the approach task (Field & Price-Evans, 2009).

The Susceptibility to Punishment and Sensitivity to Reward Questionnaire. The 'Susceptibility to Punishment and Sensitivity to Reward Questionnaire' is a 48-item measure for both BIS and BAS (SPSRQ; Torrubia, Avila, Molto, & Caseras, 2001). A Junior self-report version of the SPSRQ has been developed, although it has not yet been published (Torrubia, Garcia-Carillo, Avila, Caseras, & Grande, in preparation; in Torrubia, et al., 2008). There is also a parent-report version of the SPSRQ available in which items inappropriate for children or problematic in factor analysis in adults were removed or reworded (Colder & O'Connor, 2004). Factor analysis of the 33 remaining items revealed a 4-factor solution. One factor represents Sensitivity to Punishment (SP) or BIS. The other three factors represent three components of Sensitivity to Reward (SR) or BAS (i.e. drive, reward responsivity, impulsivity/fun seeking). Fifteen items make up the BIS-scale and include statements as 'Criticism or scolding hurts your child very much'. BIS-scores were associated with internalizing problems \((r=.40)\). In addition to that, high BIS-scores were related to greater inhibition in response to punishment cues (but not with responsiveness to reward cues) on a point scoring reaction time task (Colder & O'Connor, 2004).
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**Note.** CBCL: Child Behavior Checklist; CBQ: Child Behavior Questionnaire; BIS/BAS-c/p: Carver & White BIS/BAS-scales (child/parent report); DOTS-R: Dimensions of Temperament Survey - Revised; EATQ-R: Early Adolescent Temperament Questionnaire - Revised; EPQ-s: Eysenck Personality Questionnaire (short inventory); GWPQ-s: Gray-Wilson Personality Questionnaire (short form); ICID: Inventory of Child Differences; n/a: not applicable; n/r: not reported; JEPQ-si: Junior Eysenck Personality Questionnaire (short inventory); PANAS-c: Positive Affect and Negative Affect Schedule for Children; RCADS-c/p: Revised Child Anxiety and Depression Scale, short form (parent/child version); RTQ: Rutter Teacher Questionnaire; SASCR: Social Anxiety Scale for Children - Revised; SCARED: Screen for Child Anxiety Related Disorders; STAI-T: State Trait Anxiety Inventory, trait scale; YSR: Youth Self-Report.
**Conclusion**

This overview of studies (Table 2.1) using BIS-measures based on RST shows that BIS-sensitivity can be measured reliably and validly in community samples, using either self-report or parent report. All BIS-scales described here, have acceptable internal reliabilities as indicated by Cronbach’s alpha coefficients. All BIS-scales are meaningfully related to questionnaires measuring relevant concepts (e.g., Neuroticism, Negative Affect, trait anxiety). In addition to that, the few studies investigating the association between BIS-sensitivity and information processing suggest the predictive validity of the BIS-concept for anxiety related cognitive processes (Field & Price-Evans, 2009; Knyazev, et al., 2008).

Notwithstanding the favorable psychometric properties of all these scales, the use of different questionnaires makes it difficult to compare and integrate results from several studies (Caseras, Avila, & Torrubia, 2003; Torrubia et al., 2008). While developed to assess RST-related concepts, the GWPQ, BIS/BAS-scales and SPSRQ differ in the exact content they assess. In GWPQ and SPSRQ, BIS-related items assess reactions to typical situations with specific aversive stimuli (e.g., GWPQ: 'I would panic in an earthquake'; SPSRQ: 'When in a group, your child has difficulty thinking of something to say'), whereas in the BIS/BAS-scales, items refer to non-specific, more general aversive situations (e.g., 'I am very fearful compared to my friends').

When information on gender difference is provided, BIS-scores are higher in girls than in boys in most studies (e.g., Slobodskaya et al., 2003; Sportel et al., in preparation), but not in all (e.g., Blair et al., 2004; Coplan et al., 2006).

Although studies using BIS-questionnaires yield interesting results, further examination of BIS-instruments is necessary. One major limitation of the RST research at the moment is that, in contrast to research with adults where the new perspective is adopted (e.g., Heym, Ferguson, & Lawrence, 2008; Jackson, 2009), none of the studies with young participants are based on the revised RST model.

Moreover, although RST is often used as a framework for studying psychopathology, and high BIS and low BAS have been studied as a vulnerability factor for social anxiety and depression respectively (Hamill, Scott, Dearing, & Pepper, 2009; Sportel, et al., in preparation), up until now, none of the questionnaires used with children or adolescents are validated in clinical youth samples. As such, information on BIS-sensitivity in clinically anxious children and adolescents is lacking.
In the remainder of this chapter, I will describe performance-based measures to assess the automatic processes related to BIS-activity. Most performance-based measurements used in RST-research involve the input of the BIS, concentrating on the 'punishment' value of the paradigm (for reviews, see Avila & Torrubia, 2008; Corr, 2004). My focus, however, will be on paradigms that are relevant for the three output modalities of the BIS: inhibition, evaluation and attention. As such, I propose an information-processing framework to study the cognitive processes and biases associated with BIS-[over]activity and anxiety.

In the first part, I will discuss studies examining inhibition in anxiety with the Stop (Signal Reaction Time) Task. In the second part, I will describe how automatic stimulus evaluations can be assessed using different indirect measures. In the third part, I will discuss recent issues in the assessment of anxiety-related attentional processes in children and adolescents using the Dot Probe Detection Task.

**Inhibition measured with the Stop Signal Paradigm**

Activity in the BIS gives rise to the inhibition of ongoing motor behavior (e.g., Gray, 1982). Therefore, it can be expected that anxiety is associated with increased levels of response inhibition. One of the most extensively used inhibition paradigms is the Stop Signal Reaction Time Task (Logan & Cowan, 1984; Logan, et al., 1984). Although the paradigm is originally described as pertaining to the inhibition of both behavioral and cognitive responses, it is mainly been used as a measure of response inhibition and an analogue for everyday life stopping (Nigg, 2000).

Although the stop task is found to be a valid and reliable index of Gray's BIS concept (Daugherty & Quay, 1991; Kindlon, Mezzacappa, & Earls, 1995) and in contrast to the large number of stop task studies investigating inhibitory deficits in externalizing problems (for recent reviews see Alderson, Rapport, & Kofler, 2007; Lijffijt, Kenemans, Verbaten, & van Engeland, 2005), stop task studies on inhibition in anxiety are scarce and have yielded virtually no support for the hypothesized enhanced inhibition in childhood anxiety. Although comorbid anxiety problems seem to decrease the inhibition deficits typically found in ADHD, inhibition in anxious children (with or without ADHD, aged 6-14) was not increased compared to control children (Korenblum, Chen,

There are methodological and theoretical explanations for the difficulty to find evidence for increased inhibition in anxiety (also see Oosterlaan et al., 1998). Most studies focus on deficient inhibition in externalizing problems, and include participants with emotional problems only as pathological controls for participants with ADHD (e.g., Korenblum et al., 2007). In such a psychiatric control group, participants with anxiety and/or depression problems are merged in one group with emotional internalizing problems. As such, it is impossible to draw conclusions on how anxiety alone may influence inhibition. When studying inhibition in anxiety, participants in the anxious group should be carefully selected and diagnosed with a primary anxiety diagnosis. Moreover, most stop task studies involve only small samples (e.g., Manassis et al. 2000), and thus may lack sufficient power to detect possible group differences between anxious and non-anxious participants. Consistent with this, when adopting a dimensional perspective on psychopathology, it was found that increasing levels of internalizing problems were related to increasing inhibition (Kooijmans, Scheres, & Oosterlaan, 2000). The theoretical explanation for the lack of evidence for increased inhibition in anxiety directly relates to Gray's original suggestion that the BIS gets activated by adequate stimuli for anxiety (i.e. aversive and threatening stimuli) (1982; 1987). Therefore, the hypothesized enhanced inhibition in anxiety would only become apparent in threatening situations (Oosterlaan et al., 1998). Consistent with this, increased inhibition related to anxiety is found in a study using the change task, a more complex variant of the stop task (Oosterlaan & Sergeant, 1998). It can be assumed that children experience the more complex task as more threatening, especially when they are anxious. Surprisingly, the idea that inhibition in anxious participants would only be enhanced in threatening situations has never been tested directly. Comparing inhibitory capacities of clinically anxious children and adolescents in threatening and non-threatening situations might be a fruitful way to investigate the inhibition output of BIS-activity. In the present dissertation, inhibition in threatening and non-threatening situations is studied using an anxiety-relevant and a neutral version of the Stop Stimulus Reaction Time Task.

Stimulus evaluation measured with the Extrinsic Affective Simon Task

A second functional output of the BIS implies a negative bias in the evaluation of stimuli (Gray & McNaughton, 2000). Various so called implicit measures (e.g., Implicit Association Test, IAT, Greenwald, McGhee, & Schwarz, 1998; Affective Priming
Paradigm, APP, Fazio, Sanbonmatsu, Powell, & Kardes, 1986; Extrinsic Affective Simon Task, EAST, De Houwer, 2003a) have been developed to assess automatic evaluations in social psychology (for review, see Fazio & Olson, 2003), addiction research (for meta-analysis, see Rooke, Hine, & Thorsteinsson, 2008), and clinical psychology (for review, see Huijding, 2006). Automatic evaluations can be measured in participants as young as six years. The IAT, for example, has been used to study the racial attitudes of children and adolescents aged 6 to 16 (e.g., Dunham, Baron, & Banaji, 2008; Baron & Banaji, 2006; Rutland, Cameron, Milne, & McGeorge, 2005; Sinclair, Dunn, & Lowery, 2005). In addition, both the IAT and the EAST were used to examine automatic evaluations of food in children with and without obesity aged 13-16 (Craeynest, Crombez, Haerens, & De Bourdeauhuij, 2007; Craeynest, Crombez, De Houwer, Deforche, Tanghe, & De Bourdeauhuij, 2005) and to study predictors of substance abuse in adolescents [e.g., Ames, Grenard, Thush, Sussman, Wiers, & Stacy, 2007; Thush, Wiers, Ames, Grenard, Sussman, & Stacy, 2007].

Implicit measures such as the IAT and the EAST have also been used to assess automatic evaluations in anxiety. In adult anxiety research, disorder specific biased automatic evaluations have been found in social anxiety [e.g., de Jong, Pasman, Kindt, & van den Hout, 2001] and in fear of spiders [e.g., Huijding & De Jong, 2005a; Teachman, Gregg, & Woody, 2001; for review, see Huijding, 2006] using both paradigms. Research on automatic evaluations in childhood anxiety, however, is scarce and all studies so far have failed to find an association between automatic evaluations and anxiety (for review, see Huijding, Wiers & Field, 2010). Automatic processing of pleasant and threat-related pictorial stimuli measured with the Affective Priming Paradigm did not differ between clinically anxious and matched non-anxious children [n=50, aged 7-14] [Spence, Lipp, Liberman, & March, 2006]. In a large sample [n=770] of adolescents [aged 12-15] at risk for social phobia, implicit self-evaluations measured with the IAT were not related to self-reported social anxiety [Sportel, de Hullu, de Jong, Nauta, & Minderaa, 2007, July].

One possible explanation why those studies failed to find evidence for an association between automatic evaluations and anxiety might relate to the lower sensitivity of indirect instruments when used with children. It is possible that these instruments do not yield the same effects and effect sizes for children as they do for adults, for example because children are more easily distracted than adults [Vasey, Dalgleish, & Silverman, 2003]. Another likely factor is that most indirect measures, even when used with adult participants, suffer from low reliability [e.g., De Houwer & De Bruycker, 2007; Schmukle & Egloff, 2006]. Since the validity of an instrument is bound by its reliability [e.g.,
Carmines & Zeller, 1979), poor internal reliability can be one reason why it is difficult to find associations between automatic evaluations and anxiety. These issues point to the importance of using age-appropriate, reliable instruments when investigating anxiety-related information processes.

In the present dissertation, a pictorial version of the EAST is used to assess automatic anxiety-relevant evaluations. There are several reasons for choosing the EAST over other indirect paradigms. One major advantage of the EAST is that it assesses simple (i.e. non-relative) evaluations (e.g., one has positive evaluations of flowers), whereas the IAT only assesses relative evaluations (e.g., one has more positive evaluations of flowers than of insects). The EAST has been used in previous studies with young participants (e.g., Ames et al., 2007; Craeynest et al., 2005; Huijding & de Jong, 2005b; Thush et al., 2007), suggesting that the paradigm can provide a valid assessment of automatic evaluations in youth samples. Although internal reliability of the original verbal EAST tends to be low, the pictorial version of the EAST provided somewhat better results. This improvement in reliability might be related to the possibility that pictures are ecologically more valid and have a more direct access to emotional information in memory (De Houwer & De Bruycker, 2007; Huijding & de Jong, 2005a, b). Using pictorial instead of verbal stimuli has the additional advantage of overcoming the differences in reading abilities in studies with children of different age groups. As such, we regard the pictorial EAST might be a promising instrument to use when investigating the evaluation output of BIS-activity.

**Selective attentional bias measured with the Dot Probe Paradigm**

Besides inhibition and stimulus evaluation, a third function of BIS-activity relates to attentional processes. One of the most popular paradigms used to study anxiety-related attentional allocation in children and adolescents is the Dot Probe Detection Task (Vasey et al., 1995). Attentional allocation on different time points can be studied by using different stimulus exposure durations. For example, when stimulus duration is short (e.g. 200 ms) initial attention is assessed, while at longer stimulus duration (e.g. 1250 ms) more strategic attentional processes can be studied.

Several studies provide evidence that anxiety is associated with biased attentional processing [for meta-analysis and review, see Bar-Haim et al. 2007; Puliafico & Kendall, 2006; Yiend, 2010]. However, while the evidence for threat-related attentional bias in anxious adults is quite convincing, results from studies with children and adolescents yield smaller effect sizes and are far less consistent [e.g., Bar-Haim et al., 2007; Puliafico & Kendall, 2006; Van Damme & Crombez, 2009]. Whereas some studies
found evidence for attentional bias towards threat (e.g., Reid, Solmon, & Lovibond, 2006; Vasey et al., 1995), others failed to do so (e.g., Benoit, McNally, Rapee, Gamble, & Wiseman, 2007; Legerstee et al., 2009; Lonigan & Vasey, 2009; Waters, Mogg, Bradley, & Pine, 2008; Watts & Weems, 2006) or found attentional avoidance related to threat (e.g., Kallen, Ferdinand, & Tulen, 2007; Morren, Kindt, Van den Hout, & Van Kasteren, 2003). Furthermore, it is unclear whether attentional bias for threat is present in both clinically anxious and non-clinically anxious children and adolescents. Whereas studies with adult participants suggest that attentional bias for threat is confined to anxious individuals, this seems not to be the case in youth. In some studies, attentional bias towards threat was restricted to anxious youth (e.g., Roy et al., 2008), whereas other studies found attentional bias in both clinically anxious and non-clinical children (e.g., Waters, Wharton, Zimmer-Gembeck, & Craske, 2008). Taken together, results of recent studies suggest that the link between attentional bias and anxiety is not as robust as once thought, at least not in children and adolescents. Procedural (e.g., paradigm, exposure time) or person-related variables (e.g., age, clinical vs. non-clinical anxiety, state or trait anxiety, temperament) seem to moderate the attentional bias effect and its relation with anxiety (Bar-Haim et al., 2007; Helzer, Connor-Smith, & Reed, 2009; Kindt & van den Hout, 2001; Lonigan, Vasey, Phillips, & Hazen, 2004; Perez-Olivas, Stevenston, & Hadwin, 2008).

Lonigan and colleagues (2004) proposed a model in which temperament moderates the relation between attentional processes and anxiety (Figure 2.1). According to the model, high levels of reactive temperament [comparable with high levels of BIS-activity] are associated with an initial attentional bias towards threat-related information. This combination of high reactivity and attentional focus on threat potentially causes the onset of anxiety disorders. Regulative temperamental processes [as effortful control] however, moderate the relationship between attentional bias and anxiety. High levels of regulative control enable individuals to override the initial reactive attentional bias, and thus serve as a protective factor against the development of pathological anxiety. Low levels of regulative control, however, prevent individuals from overriding the initial reactive bias. As such, they remain stuck with a later attentional bias which could result in anxiety disorders.

Studying threat-related attentional biases is an interesting approach to investigate the attention output of BIS-activity. By studying a model in which attention is linked to reactivity, regulative capacities and anxiety problems, knowledge on the associations between personality/temperament and psychopathology can be increased. In the present dissertation, a dot probe task with different stimulus exposure durations is
used to test the Lonigan et al. (2004) model on the relations between temperament, attentional bias and anxiety severity.

**Conclusion**

Although inhibition, automatic evaluations and attentional processes are frequently studied as cognitive correlates of anxiety, results are seldom interpreted in terms of BIS-activity (for a different view, see Avila & Torrubia, 2008). Nevertheless, it might be a valuable approach to study BIS-activity from an information-processing paradigm, and investigate cognitive processes as indices of functional BIS-outputs (Chapters 4-6).