At risk of depression and anxiety
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Chapter 6

Effortful control, neuroticism, and extraversion: Effects on anxiety and depression

Individuals proficient in temperamental effortful control appear better able to regulate reactive temperamental traits such as neuroticism and extraversion. The present study investigated whether effortful control, and its sub-components attentional, inhibitory, and activation control, protected against anxiety and depression, directly, or through modulation of the effects of neuroticism and extraversion. We used a longitudinal design and a high-risk sample of adolescent and young adult offspring of parents with an anxiety or mood disorder (n=447). Effortful control protected against depression, through attentional and activation control, and against anxiety in individuals high on neuroticism, through attentional and inhibitory control. Findings were consistent across time and stood firm next to the protective effects of extraversion. Attentional control is discussed in light of the ability to disengage from threats or rumination on loss or failure; inhibitory control in light of cognitive inhibition and free working memory space needed by highly neurotic or extraverted individuals for anxiety regulation; and activation control in light of an orientation towards action and self discipline which attenuates the build-up of further sad affect.

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Introduction

We do not all run the same risk of developing anxiety or mood disorders. Part of this variation in susceptibility depends on our personalities or temperaments. Research has established that neuroticism (similar to negative affectivity, the Behavioral Inhibition System [BIS], and the defense system [cf. Evans & Rothbart, 2007; Carver, 2005; Carver, Sutton, & Scheier, 2000], hereafter referred to as neuroticism) is the strongest and most robust susceptibility trait for anxiety and mood disorders. This holds for adults (e.g., Clark, Watson, & Mineka, 1994; Jorm et al., 2000; Ormel, Oldehinkel, & Brilman, 2001; Roberts & Kendler, 1999) as well as for children (e.g., Caspi et al., 1996; John et al., 1994; Lonigan et al., 1997). Neuroticism may be described as emotional instability or a pervasive tendency to experience negative emotions (Eysenck, 1967; Eysenck & Rachman, 1965; John, 1990) and is thought to relate, in particular, to reactivity of the limbic system (Gray, 1982; Kagan & Snidman, 2004).

Neuroticism tends to predict anxiety and depression alike. More specificity in differentially predicting anxiety and depression has been sought by taking into account a second personality trait, extraversion. Extraversion (similar to the Behavioral Activation System [BAS] and the approach or appetitive system [cf. Carver, 2005; Carver Sutton, & Scheier, 2000], hereafter referred to as extraversion) may be described as the tendency to engage in the pursuit of possible incentives, with sub-components such as reward sensitivity, sociability and eagerness, and is thought to relate, in particular, to reactivity of the dopaminergic system (Carver, Sutton, & Scheier, 2000; Depue & Collins, 1999; Derryberry & Tucker, 2006). Low extraversion is hypothesized to particularly underlie depression while being less relevant for anxiety (e.g., Angst, 1998; Carver, 2004; Clark, Watson, & Mineka et al., 1994; Davidson, 1995; Depue & Iacano, 1989). Empirical findings with regard to such differentiation have nonetheless been mixed, and associations between extraversion and anxiety have been reported as well (Bienvenu et al., 2001a; Brown, Chorpita, & Barlow, 1998; Trull & Sher, 1994). One proposed source for this is the high comorbidity between anxiety and depression, which has often not been controlled for (Middeldorp et al., 2006). Besides, literature suggest that the association between low extraversion and anxiety is, in fact, theoretically sound in case of high neuroticism. That is, the overactive defense system in neurotic individuals who are susceptible for anxiety disorders may reduce approach behavior as a form of reactive self-protection (Derryberry & Rothbart, 1997; Derryberry & Tucker, 2006). Thus, part of the inconsistency in findings may be due to the presence of an interaction between neuroticism and extraversion, which, if not modeled, may sometimes present as a main
effect. Two studies, so far, addressed this interaction, one supporting its presence (Gershuny & Sher, 1998) and one not (Jorm et al., 2000).

A temperamental trait that has more recently come into focus regarding its relation with psychopathology is effortful control (see for two recent overviews, Carver, 2005; Nigg, 2006). The notion of effortful control comes from a body of research by Rothbart and her colleagues (cf. Derryberry & Rothbart, 1997; Rothbart & Bates, 1998) wherein a distinction is proposed between individual differences in reactive traits such as neuroticism and extraversion and individual differences in effortful regulatory traits, subsumed in her model under the name of effortful control (similar to ego resiliency [Block & Block, 1980; Carver, 2005] and related to conscientiousness [Nigg, 2000]). Effortful control can be viewed as a set of relatively deliberate control functions needed for voluntary goal-directed behavior (Derryberry, 2002) similar to the domain of executive functioning as described in the neuropsychological literature (Nigg, 2006). In Rothbart's questionnaires, effortful control is operationalized as the operational efficiency of the executive functions in natural settings (cf. Rueda, Posner, & Rothbart, 2004). Individuals with a high capacity for effortful control are good at sustaining their focus on a task or shifting their attention from one task to another as desired (attentional control), withholding responses which are irrelevant, unintended, or inappropriate (inhibitory control), and executing behavior even if this involves activities which are not particularly pleasurable (activation control). The prefrontal cortex in particular is responsible for such high-level executive processing. Importantly, effortful control can be seen as an important trait for voluntary self-regulation, allowing the individual to break out of their reactive tendencies such as high negative emotionality (neuroticism) and reward sensitivity (extraversion). Recent insights from neuro-imaging studies support this proposition. For example, such studies have shown the importance of the role of the prefrontal cortex in attenuating subcortical limbic activation (Hariri et al., 2003; Ochsner et al., 2004). Similarly, in an epidemiological context, attentional regulation, as one sub-component of effortful control, has been shown to interact with emotionality (Eisenberg et al., 2000). Therefore, ineffective regulation of the motivational response systems by effortful control systems may be an important vulnerability factor for psychopathology (Nigg, 2006).

This appealing idea has been investigated and confirmed mostly for children with externalizing disorders (e.g., Eisenberg et al., 1996; Eisenberg et al., 2000; Eisenberg et al., 2001; Lemery, Essex, & Smider, 2002; Lengua, West, & Sandler, 1998; Nelson et al., 1999). Research on the protective role of effortful control for anxiety and mood disorders is still scarce, and the studies that have been done have yielded less consistent as well as smaller effects relative to the externalizing disorders. This led some investigators to propose that effortful control may be more important for the regulation of anger,
approach, positive emotions and exuberance (Rydell, Berlin, & Bohlin, 2003). Others concluded that the regulation of fear, sadness, avoidance and withdrawal has not received enough explicit study as yet (Carver, 2005). There are nonetheless a number of findings that are suggestive of a protective role of (sub-components of) effortful control against anxiety, or more broadly, internalizing problems. Lengua et al. (1998) reported negative cross-sectional correlations between attentional control and parent and self-rated internalizing symptoms in children. Similarly, Eisenberg et al. (2001) reported diminished effortful control in children with internalizing problems relative to healthy children. Also in a cross-sectional study, Muris, De Jong, and Engelen (2004) showed that attentional control was negatively associated with anxiety in children. In a longitudinal study, Lerny et al. (2002) found negative correlations of inhibitory control and attentional control with father- and mother-rated internalizing problems in children. Also in a longitudinal study, Lengua et al. (2005) showed that inhibitory control was negatively associated with post-traumatic anxiety symptoms following the 9/11 terrorist attack. Importantly, three studies have tested the suggestion put forward by Eisenberg and Morris (2002) and Lonigan, Vasey, and Phillips (2004), among others, that the effects of high neuroticism and low effortful control are mutually enhancing to produce an even worse outcome relative to their separate additive effects. Such an interaction effect was found for adolescents' internalizing problems in a cross-sectional study by Muris (2006) and in a longitudinal study by Oldehinkel et al. (2007), but not in the aforementioned study by Muris, De Jong and Engelen (2004) in children.

The findings as reviewed above show that the question as to which personality or temperament dimensions play a role in anxiety and mood disorders above and beyond neuroticism is far from resolved. In the present study we include the "Big Three", that is, neuroticism, extraversion, and effortful control, with an emphasis on the least investigated trait in relation to anxiety and depression, that is, effortful control. One aim of this study is to investigate whether the protective role of effortful control as it has been found in the handful of studies conducted so far is robust when the possibly protective (i.e., fear reducing or mood elevating) effects of extraversion are included in the model as well. Muris et al. (2004) suggested that one possible source for the mixed findings for effortful control in relation to anxiety may be that extraversion has not been taken into account. To date no studies have investigated the combined influence of neuroticism, extraversion, and effortful control on anxiety. A second aim is to determine whether the protective role of effortful control, additive or in interaction with neuroticism or extraversion, extends to depression, which, as is clear from a recent overview on temperament and psychopathology (Nigg, 2006), has not yet been investigated. A third aim is to clarify the hypothesized protective role of effortful control in terms of the sub-components attention,
inhibition, and activation control. Leading researchers in the field of temperament (Derryberry & Tucker, 2006; Eisenberg et al., 2005a; Nigg, 2000; Nigg, Hinshaw, & Huang-Pollock, 2006) have argued for differentiation among different types of effortful control. With regard to anxiety and depression, some studies focused on attentional control, other studies on inhibitory control, but activation control has not been studied so far, nor has the relevance of these three types of voluntary control been determined within a single study. Not only additive but also interactive effects of neuroticism, extraversion and (subcomponents of) effortful control on symptom severity are considered. While the importance of studying interactive effects of personality traits on psychopathology is acknowledged (Klein et al., 2002), still little empirical work has been done in this direction.

Method

Sample
The sample is a high-risk sample. Participants are adolescent and young adult children of parents with a mood or anxiety disorder. They take part in the ARIADNE study, which is short for ‘Adolescents at Risk of Anxiety and Depression; A combined Neurobiological and Epidemiological approach’. The participants of the ARIADNE study are followed over time in order to further our understanding of the etiological factors involved in the onset and course of anxiety and mood disorders. They were recruited through their parents who were recruited themselves from 16 psychiatric services in the three northern provinces of the Netherlands. Parents had been treated at least once in their lifetime for a mood or anxiety disorder. Their adolescent and young adult children could participate in the study if they were between 13 and 26 years old. Parents received information about the study by mail and were asked if they had biological children in the appropriate age-range, and if so, to confer with their children about participation in the study. While the parents had a mood or anxiety disorder, there were no in- or exclusion criteria as to whether the adolescents and young adult participants had a psychiatric disorder or not. The study design has been described more extensively by Landman-Peeters et al. (2005). For the purpose of the present study we used the data from three measurement occasions, each with one year apart: temperament measured at baseline (T1) and anxiety and depression outcome variables at one (T2) and two year follow-up (T3). A total of 447 (176 males and 271 females) adolescents and young-adults had complete data on the measures used here. When recruited, their mean age was 18.7 years ($SD=3.3$).
Measures

Psychopathology. Depression and anxiety symptoms were measured with items from the DSM-IV Questionnaire by means of self-report (Hartman, 2002; Hartman et al., 2001; Landman-Peeters et al., 2005; Muris, 2006; Muris, Winands, & Horselenberg, 2003). Participants were asked to report on a 4-point Likert-scale as to what extent descriptions of symptomatic behavior had applied to themselves with regard to the previous 12 month-period, that is, between T1 and T2, and between T2 and T3.

An important methodological challenge is to differentiate between anxiety and depression. Anxiety and depression are often comorbid conditions; hence anxiety and depression scales are often highly correlated. However, apart from this true co-occurrence of anxiety and depression symptoms, measurement is often imprecise such that measures of anxiety often include items that measure depression, and vice versa (cf. Chorpita & Daleiden, 2002; Stark & Laurent, 2001). Therefore, we took great care to tease our measures of anxiety and depression apart. This was done by exploratory factor analyses of the DSM-IV symptom ratings at T1, T2 and T3, respectively, using the maximum likelihood estimation method with oblique (promax) rotation. We selected items that had a main factor loading of at least 0.30 on the appropriate scale and a difference of at least 0.20 between the main loading and the secondary loading if present. To ensure robustness of the findings, these criteria needed to be fulfilled at all three measurement occasions. (Note that while for our substantive analyses we chose a longitudinal perspective, with temperament [T1] predating anxiety and depression outcome measures [T2 and T3], for these factor analyses information of T1 DSM-IV ratings was additionally included for the purpose of constructing subscales that are maximally stable in their differentiation of anxiety and depression).

Table 1 shows the factor solutions of the items that behaved according to these criteria, at T1, T2, and T3. The depression factor consists of items that emphasize sad affect, loss of pleasure, reduced energy, low self-worth, and the absence of positive affect (rescored). The anxiety factor consists of items that emphasize panic-related symptoms and physiological hyper-arousal symptoms that accompany these. Items that were originally included in the analyses but were not retained measured several worries that pertain to Generalized Anxiety Disorder. They did not differentiate between anxiety and depression (high loadings on both the anxiety and the depression factor), which is consistent with the literature (Brown, Chorpita, & Barlow, 1998; Krueger, 1999; Vollebergh et al., 2001).

The items of the depression and anxiety factors that fulfilled the criteria were summed. Internal consistency reliabilities were 0.93 and 0.92 for the Depression scales at
The following table shows factor loadings on anxiety and depression factors at T1, T2, and T3 (N=447).

<table>
<thead>
<tr>
<th>Item</th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 1</th>
<th>Factor 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>I was extremely nervous</td>
<td>-0.076</td>
<td>0.552</td>
<td>0.137</td>
<td>0.476</td>
<td>-0.106</td>
<td>0.566</td>
</tr>
<tr>
<td>I had difficulty going places when not accompanied by my parent(s)</td>
<td>-0.081</td>
<td>0.376</td>
<td>0.037</td>
<td>0.295</td>
<td>0.001</td>
<td>0.380</td>
</tr>
<tr>
<td>I panicked when I was alone outside the home</td>
<td>-0.123</td>
<td>0.662</td>
<td>-0.042</td>
<td>0.643</td>
<td>-0.239</td>
<td>0.820</td>
</tr>
<tr>
<td>I felt panic when I had to travel on my own (like by car, on the train or on the bus)</td>
<td>-0.153</td>
<td>0.679</td>
<td>-0.210</td>
<td>0.791</td>
<td>-0.167</td>
<td>0.721</td>
</tr>
<tr>
<td>I panicked in crowded places</td>
<td>-0.038</td>
<td>0.661</td>
<td>-0.110</td>
<td>0.759</td>
<td>0.008</td>
<td>0.710</td>
</tr>
<tr>
<td>I had moments that I had intense fear that I would die</td>
<td>0.066</td>
<td>0.431</td>
<td>0.003</td>
<td>0.550</td>
<td>-0.051</td>
<td>0.535</td>
</tr>
<tr>
<td>I feared losing control (such as by doing embarrassing things, fainting, etc.)</td>
<td>-0.077</td>
<td>0.685</td>
<td>-0.039</td>
<td>0.748</td>
<td>-0.069</td>
<td>0.778</td>
</tr>
<tr>
<td>I was really concerned about what I felt in my body</td>
<td>-0.019</td>
<td>0.675</td>
<td>0.141</td>
<td>0.508</td>
<td>0.076</td>
<td>0.567</td>
</tr>
<tr>
<td>I suddenly became very anxious in situations where most people are not anxious</td>
<td>0.105</td>
<td>0.606</td>
<td>0.044</td>
<td>0.654</td>
<td>-0.016</td>
<td>0.765</td>
</tr>
<tr>
<td>I felt dizzy</td>
<td>0.065</td>
<td>0.467</td>
<td>0.195</td>
<td>0.391</td>
<td>0.137</td>
<td>0.472</td>
</tr>
<tr>
<td>I was trembling or shaking</td>
<td>0.026</td>
<td>0.535</td>
<td>0.065</td>
<td>0.445</td>
<td>0.073</td>
<td>0.533</td>
</tr>
<tr>
<td>I had a feeling that I would suffocate</td>
<td>0.156</td>
<td>0.364</td>
<td>0.161</td>
<td>0.411</td>
<td>0.144</td>
<td>0.450</td>
</tr>
<tr>
<td>I suffered from palpitations</td>
<td>-0.007</td>
<td>0.598</td>
<td>0.176</td>
<td>0.406</td>
<td>0.141</td>
<td>0.576</td>
</tr>
<tr>
<td>I was troubled by numbness or tingling sensations in my arms or legs</td>
<td>0.032</td>
<td>0.358</td>
<td>-0.110</td>
<td>0.542</td>
<td>-0.121</td>
<td>0.636</td>
</tr>
<tr>
<td>I felt nauseous</td>
<td>0.044</td>
<td>0.478</td>
<td>0.089</td>
<td>0.464</td>
<td>0.041</td>
<td>0.490</td>
</tr>
<tr>
<td>I had stomachaches</td>
<td>0.027</td>
<td>0.499</td>
<td>0.052</td>
<td>0.463</td>
<td>0.209</td>
<td>0.443</td>
</tr>
<tr>
<td>I worried a lot that I might be ill</td>
<td>-0.058</td>
<td>0.621</td>
<td>0.035</td>
<td>0.599</td>
<td>0.074</td>
<td>0.564</td>
</tr>
<tr>
<td>I felt dejected</td>
<td>0.732</td>
<td>0.155</td>
<td>0.871</td>
<td>0.012</td>
<td>0.830</td>
<td>0.045</td>
</tr>
<tr>
<td>I felt like crying</td>
<td>0.616</td>
<td>0.229</td>
<td>0.765</td>
<td>0.078</td>
<td>0.630</td>
<td>0.078</td>
</tr>
<tr>
<td>I felt helpless</td>
<td>0.619</td>
<td>0.227</td>
<td>0.764</td>
<td>0.084</td>
<td>0.679</td>
<td>0.218</td>
</tr>
<tr>
<td>I felt worthless</td>
<td>0.626</td>
<td>0.234</td>
<td>0.701</td>
<td>0.188</td>
<td>0.728</td>
<td>0.151</td>
</tr>
<tr>
<td>I had little faith in my achievements</td>
<td>0.493</td>
<td>0.218</td>
<td>0.452</td>
<td>0.180</td>
<td>0.466</td>
<td>0.205</td>
</tr>
<tr>
<td>I felt pessimistic about the future</td>
<td>0.547</td>
<td>-0.010</td>
<td>0.682</td>
<td>-0.085</td>
<td>0.539</td>
<td>0.128</td>
</tr>
<tr>
<td>I was low on energy and felt tired without apparent reason</td>
<td>0.461</td>
<td>0.254</td>
<td>0.595</td>
<td>0.143</td>
<td>0.601</td>
<td>0.168</td>
</tr>
<tr>
<td>I experienced little pleasure in daily things</td>
<td>0.840</td>
<td>-0.122</td>
<td>0.733</td>
<td>0.026</td>
<td>0.725</td>
<td>0.010</td>
</tr>
<tr>
<td>I lost my interest in things or activities</td>
<td>0.670</td>
<td>-0.058</td>
<td>0.653</td>
<td>0.001</td>
<td>0.690</td>
<td>-0.119</td>
</tr>
<tr>
<td>I was inactive, I could not get things going, I felt “slowed”</td>
<td>0.549</td>
<td>0.132</td>
<td>0.560</td>
<td>0.086</td>
<td>0.596</td>
<td>0.040</td>
</tr>
<tr>
<td>I thought about committing suicide</td>
<td>0.504</td>
<td>0.095</td>
<td>0.492</td>
<td>0.027</td>
<td>0.419</td>
<td>0.085</td>
</tr>
<tr>
<td>I was happy (rescored)</td>
<td>0.819</td>
<td>-0.247</td>
<td>0.690</td>
<td>-0.160</td>
<td>0.715</td>
<td>-0.205</td>
</tr>
<tr>
<td>I enjoyed things (rescored)</td>
<td>0.710</td>
<td>-0.166</td>
<td>0.647</td>
<td>-0.086</td>
<td>0.720</td>
<td>-0.127</td>
</tr>
<tr>
<td>I had enough energy to do my daily duties (rescored)</td>
<td>0.567</td>
<td>0.000</td>
<td>0.500</td>
<td>-0.027</td>
<td>0.546</td>
<td>-0.075</td>
</tr>
<tr>
<td>I was optimistic about the future (rescored)</td>
<td>0.728</td>
<td>-0.147</td>
<td>0.658</td>
<td>-0.098</td>
<td>0.686</td>
<td>-0.105</td>
</tr>
<tr>
<td>I felt good about myself (rescored)</td>
<td>0.714</td>
<td>-0.016</td>
<td>0.647</td>
<td>-0.023</td>
<td>0.728</td>
<td>-0.085</td>
</tr>
</tbody>
</table>
Temperament. Temperament was measured by means of the Adult Temperament Questionnaire (ATQ) (Rothbart, Ahadi, & Evans, 2000). Participants rated the items on a 4-point Likert scale with 1 indicating that the item does not at all describe the person and 4 indicating an item to be highly descriptive of the person.

Neuroticism, or negative affectivity in Rothbart’s terminology, is associated with potentially threatening or unpleasant stimuli and the experience of negative feelings. The sub-components comprised by the total Negative affectivity scale of the ATQ are Fear (unpleasant affect associated with anticipation of pain or distress), Frustration (unpleasant affect associated with task interruption or the blocking of a desired goal), Reactive sadness (unpleasant affect and lowered mood related to disappointment, loss, and exposure to suffering), and Discomfort (negative affect related to stimulation of visual, auditory, smell/taste and tactile stimulation) (Derryberry & Rothbart, 1988; Evans & Rothbart, 2007). The items pertaining to each of these sub-components were summed. Estimates of the correlation between negative affectivity in the ATQ and measures of Big Five neuroticism are fairly high (around 0.70) (Evans & Rothbart, 2007). Internal consistency reliability was 0.85 for the Negative affectivity scale in our sample.

Extraversion is associated with potentially appetitive stimuli and the experience of positive affect. The different sub-components comprised by the total Extraversion scale are High intensity pleasure (enjoyment related to high levels of novelty and intensity), Sociability (enjoyment derived from social interaction and being in the presence of others), and Positive affectivity (intensity, duration, frequency, rate of onset, and rising intensity of pleasure). Extraversion as operationalized in the ATQ maps fairly well on measures of extraversion of the Big Five model (correlations around 0.65) (Evans & Rothbart, 2007). Internal consistency reliability was 0.82 for the Extraversion scale in our sample.

Effortful control comprises a set of control functions needed for voluntary goal-directed behavior similar to the domain of executive functioning as described in the neuropsychological literature. It is operationalized by the sub-components Attentional control (capacity to voluntary focus as well as shift attention), Inhibitory control (capacity to suppress inappropriate approach behavior), and Activation control (capacity to perform activities that one would rather avoid). Note that inhibitory control, that is, voluntary, flexible control of behavior, is separate from behavioral inhibition, which refers to reactive suppression of behavior motivated by fear or shyness (Carver, 2005; Kagan & Snidman, 2004). Behavioral inhibition is more directly associated with the personality trait of neuroticism and hence a risk rather than a protective factor for psychopathology.
(Rothbart & Bates, 1998). Effortful control shows a substantial correlation with conscientiousness of the Big Five model (around 0.60) (Evans & Rothbart, 2007). Internal consistency reliability was 0.84 for the Effortful control scale in our sample. In the present study, we focused specifically on the sub-components of Effortful control. Internal consistencies were 0.80, 0.68, and 0.78 for Attention, Inhibition, and Activation control, respectively.

Statistical analyses

Zero-order correlation coefficients of all relevant measures were calculated for basic insight into patterns of association in the data. Next, we conducted a series of hierarchical regression analyses to examine main and moderating effects of temperament on anxiety and depression. The regression analyses were done in two steps. In step 1 we investigated the main effects of neuroticism, extraversion, and effortful control as measured on T1 on anxiety and depression at T2 and T3. Effortful control was studied both at the aggregated and at sub-component level, that is, attentional control, inhibitory control, and activation control, respectively. In step 2 these analyses were repeated with the inclusion of all two- and three-way temperament interactions in the regression equations. Analyses were done for both T2 and T3 to determine whether effects were consistent across time. In all regression analyses we controlled for gender and age.

Results

Bivariate associations

Zero-order correlations between T1 temperamental traits, gender, age, and T2 and T3 psychopathology are presented in Table 2 for purposes of data description. Both anxiety and depression are highly stable from T2 to T3, depression somewhat less than anxiety. Consistent with this, age is not correlated with anxiety, but shows some positive association with depression. Anxiety and depression are more strongly associated at T2 than at T3, suggesting more differentiation when participants get older. Gender shows a somewhat stronger association with anxiety than with depression, with the higher scores for girls.

Neuroticism at T1 is correlated about equally with anxiety and depression, at T2 and T3, with a minor reduction in magnitude with passing of time. Extraversion at T1 is more strongly correlated with depression than with anxiety, at T2 and T3 also with some reduction across time. The correlations of sub-components of effortful control at T1 with
Table 2 Pearson correlation matrix of T2 anxiety and depression, and T3 anxiety and depression and T1 neuroticism, extraversion, effortful control, gender, and age (n=447)

<table>
<thead>
<tr>
<th></th>
<th>T2 anxiety</th>
<th>T2 depression</th>
<th>T3 anxiety</th>
<th>T3 depression</th>
<th>T1 neuroticism</th>
<th>T1 extraversion</th>
<th>T1 effortful control</th>
<th>T1 inhibitory control</th>
<th>T1 activation control</th>
<th>Gender</th>
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Correlations <0.10 were not significant from zero at α=0.05

Anxiety and depression are rather stable across time, with similar associations of attentional control with anxiety and depression, inhibitory control somewhat more strongly correlated with anxiety than with depression, and activation control somewhat more strongly correlated with depression than with anxiety.

Neuroticism has a moderate negative correlation with extraversion as well as with effortful control. The latter effect is strongest for attentional control, followed by inhibitory control, and activation control. Extraversion is not correlated with effortful control. The latter null effect constitutes a mixture of small positive correlations with attention and activation control and a small negative correlation with inhibitory control.
### Table 3: T2 anxiety and T3 anxiety regressed on T1 temperament variables (n=447)

<table>
<thead>
<tr>
<th>Model</th>
<th>Neuroticism, extraversion, and effortful control</th>
<th>Neuroticism, extraversion and attentional control</th>
<th>Neuroticism, extraversion, and inhibitory control</th>
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</table>

Gender and age were part of the regression equation in all analyses; the dependent variables were standardized; cross-products were formed of the z-scores of individual predictors in the equation; thus the B-coefficients represent the proper standardized solution (see Cohen et al., 2003, p. 283).
Main and interactive effects of temperament on anxiety

Table 3 provides the results of the regression analyses with anxiety at T2 and T3 as the dependent variable. T1 predictors were neuroticism and extraversion with effortful control, attentional control, inhibitory control, or activation control, respectively. Only statistically significant regression coefficients are listed to simplify presentation.

A consistent and substantial main effect for neuroticism was found. Thus, as has repeatedly been shown in previous research, high temperamental neuroticism as measured at T1 predicts later anxiety complaints at T2 and T3. We found no main effects for extraversion or effortful control, nor for any of the sub-components attentional control, inhibitory control, or activation control, respectively. This held both at T2 and T3.

There were no three-way but several two-way interaction effects. We found a consistent interaction effect between neuroticism and extraversion on anxiety, at T2. This was replicated for T3 anxiety. To interpret this interaction effect, we plotted the two-way interactions for one standard deviation above and below the mean on neuroticism and extraversion, holding effortful control, or its sub-components, constant at the mean score level. The plots were very similar across all eight analyses. Figure 1 illustrates the interaction between neuroticism and extraversion at T2, at mean levels of effortful control. Adolescents with relatively high neuroticism tend to have less anxiety complaints.

Figure 1 Interaction effect of neuroticism and extraversion on anxiety
when they are extraverted than when they are introverted. Conversely, adolescents with relatively low neuroticism who are extraverted tend to have somewhat more anxiety complaints. Thus, extraversion reduces anxiety in combination with neuroticism, but enhances anxiety somewhat in combination with low neuroticism.

We found a two-way interaction between neuroticism and effortful control on anxiety problems at T2. This effect was replicated for T3 anxiety. Figure 2 illustrates, for T2, at mean levels of extraversion, that individuals with high neuroticism have less anxiety complaints when they have high effortful control than when they have low effortful control. Effortful control is irrelevant for anxiety problems at relatively low levels of neuroticism.

![Figure 2](image_url)  
**Figure 2** Interaction effect of neuroticism and effortful control on anxiety

Looking subsequently in more detail at the three sub-components of effortful control, the results in Table 3 indicate that this effect holds for attentional control and inhibitory control, but not for activation control. These effects were consistent for T2 and T3. The plots for attentional control and inhibitory control were very similar to those for effortful control (as was illustrated by Figure 2).

At the sub-component level we found one additional interaction between inhibitory control and extraversion. This effect was present both at T2 and T3. Figure 3 illustrates, for T2, that, at average levels of neuroticism, high inhibitory control protects only for anxiety in individuals who are high on extraversion. At low levels of extraversion, individuals with high inhibitory control have similar anxiety scores as those with low inhibitory control.
Main and interactive effects of temperament on depression
Statistically significant effects of T1 temperament on T2 and T3 depression are provided in Table 4. Our analyses of the main effects revealed, firstly, an effect for neuroticism on depression symptoms: high neuroticism predicts depression. This effect was consistent for T2 and T3. Secondly, we found a main effect of extraversion, that is, introverted individuals are more likely to experience depression symptoms than extraverted individuals. This effect was present at T2 and T3. Thirdly, we found main effects of effortful control and two of its sub-components, i.e., attentional control and activation control. High effortful control is associated with lower depression scores. Attentional control and activation carry this effect but not inhibitory control. Again, these effects were consistent at both T2 and T3. Together these three main effects indicate that individuals with high neuroticism, low extraversion, and low effortful control have the highest depression scores, while individuals low on neuroticism, high on extraversion, and high on effortful control have the lowest depression scores.

On top of these main effects, we found three-way interaction effects between neuroticism, extraversion, and effortful control, and its sub-components, for all but one analysis (i.e., analysis 4 at T2, $\beta=0.04$, $p=0.13$). These three-way interactions were plotted and showed that the aforementioned main effects can be qualified as follows: The protective effect of extraversion for depression (main effect) is reduced or absent in individuals with low neuroticism and high effortful control. Thus, in those who are least depression prone, high or low extraversion makes little difference. These three-way interaction effects are illustrated by Figure 4 which depicts activation control at T3.
### Table 4. T2 depression and T3 depression regressed on T1 temperament variables (n=447)

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Gender and age were part of the regression equation in all analyses; the dependent variables were standardized; cross-products were formed of the z-scores of individual predictors in the equation; thus the B-coefficients represent the proper standardized solution (see Cohen et al., 2003, p. 283).
In the present paper we investigated the simultaneous effects of the “Big Three” in temperament research (cf. Carver, 2005; Nigg, 2000; Rothbart, Ahadi, & Evans., 2000), that is, neuroticism, extraversion, and effortful control, on anxiety and depression. The emphasis was particularly on effortful control, and its sub-components attentional, inhibitory, and activation control. This was done using a longitudinal design in a high-risk sample of adolescent and young adult offspring of parents with an anxiety or mood disorder. We found that effortful control protected against anxiety in individuals high on neuroticism. The protective role of effortful control extended to depression, as a main effect, that is, regardless of someone's stance on neuroticism. In terms of effortful control’s sub-components, attentional control and inhibitory control in particular were responsible for the effects on anxiety, while attentional and activation control protected particularly against depression. These effects of effortful control stood firm next to the protective effects of extraversion, which, consistent with the literature, were found for anxiety only in individuals high on neuroticism, and for depression as a main effect. The findings were remarkably robust across the two measurement occasions.

Attentional control was protective for both anxiety and depression. The proposed working would be through the ability to cut off negative emotion by shifting attention from threatening stimuli, worries, or self-depreciating thoughts and focus attention on alternative, affectively neutral or positive thoughts or stimuli (Eisenberg et al., 2005a;
Eisenberg & Fabes, 1992; Rothbart, Ziaie, & O’Boyle, 1992). Indeed, direct evidence of the inability to shift attention away from negative stimuli has been shown by studies using an experimental design in anxious (Derryberry & Reed, 2002; Fox, Russo, & Dutton, 2002) as well as dysphoric (Koster, et al., 2005) participants. Difficulties with disengaging from threatening stimuli perpetuates the continuous processing of this information and hence enhances vulnerability to anxiety disorders (Nigg, 2006). Similarly for depression, rumination can be viewed as a difficulty to volitionally distract one’s attention towards something else rather than the unpleasant event (Larsen & Prizmic, 2004; Nolen-Hoeksema, 1993). Present and past studies (Muris, 2006; Oldehinkel et al., 2006) thus suggest that volitional attentional control constrains such biased information processing.

The ability for inhibitory control, which involves down-regulation of irrelevant, unintended, or inappropriate responses, protected against anxiety. This held for those who were high on neuroticism, as well as for those high on extraversion. Inhibitory control was not associated with depression. Although previous studies on temperament inhibitory control and anxiety did not consider interaction effects, their findings are consistent with ours in showing a protective effect (Lemery, Essex, & Smider, 2002; Lengua, Long, & Smith, 2005). Besides its role in the temperament literature, inhibitory control plays a prominent role in the cognitive literature (Nigg, 2000). Findings on the nature of the association between experimental measures of inhibitory control and anxiety diverge. Better performance (Krikorian, Zimmerman, & Fleck, 2004; Murray & Kochanska, 2002; Thorell, Bohlin, & Rydell, 2004), equal performance (Daugherty, Quay, & Ramos, 1993; Oosterlaan & Sergeant, 1996; Schachar & Logan, 1990), as well as worse performance (Segal, 1996; Tannock, Ickowicz, & Schachar, 1995; Yee & Vaughan, 1996) in anxious respondents relative to normal controls have been reported. Differences in cognitive tasks across these studies likely explain this apparent inconsistency. Better or equal performance for anxious individuals relative to normal controls has been found on relatively pure tasks of response inhibition, such as Go/NoGo and Stop-signal tasks. In contrast, worse performance has been found when inhibition was operationalized in terms of cognitive inhibitory control that involved working memory and control of interfering information. Thus, the neuropsychological literature seems consistent in that anxious individuals are not impaired in primary motor inhibition per se. By contrast, decreased working memory in anxious individuals is consistent with the two major theories on anxiety and cognitive performance by Eysenck and Calvo (1992) and Humphreys and Revelle (1984), respectively. Importantly, our questionnaire measure of inhibitory control (ATQ), operationalized in terms of everyday situations, indeed taps more complex response organization than the interruption of prepared motor responses. For example, the behaviors comprised by the items may require individuals to step out of the immediate
situation, consider long term consequences of the dominant response, consider possible response options, and choose a subordinate response if deemed necessary. This requires interference control, or control over the contents of working memory, working in union with motor control (cf. Mitchell, Macrae & Gilchrist, 2001; Yee & Vaughan, 1996). Consistent with this line of reasoning, inhibitory control using the ATQ (as used here), or the child equivalent measure (CBQ) were shown to be negatively associated with cognitive interference as measured in laboratory tasks (Gerardi-Caulton, 2000; Posner et al., 2002). In sum, our findings of lower anxiety in individuals with higher ability for inhibitory control seem consistent with findings from the cognitive literature as indicated by performance on inhibition tasks that require working memory and interference control. We propose that real-life inhibitory control as measured in the ATQ requires motor control working in concert with working memory. Individuals proficient on this, who are also high on neuroticism may have just that extra bit of oversight so as not to let oneself flood with feelings of anxiety. In the same manner for exuberant, socially outgoing and reward oriented individuals, the ability to control approach tendencies through reflection and motor inhibition may hold positive affective arousal in a more manageable and pleasurable (rather than anxiety evoking) range (Fox & Calkins, 2003).

Activation control measures the capacity to perform mundane actions that have few tangible incentives, yet ought to be done nonetheless. The ability to mobilize and sustain the execution of such less preferred behaviors was found to protect against depression, but not anxiety. While, to our knowledge, the association between temperamental activation control and depression has not been studied before, the present protective effect seems consistent with findings from the broader domain of adult personality research. Firstly, self-discipline, a facet of the higher order personality trait conscientiousness, which taps the ability to begin tasks and complete them despite boredom, shows the highest conceptual overlap with activation control. It has been shown that relative to the other five facets of conscientiousness low self-discipline has the strongest association with depression (Bienvenu et al., 2001b; Rector et al., 2002) as well as with suicidal ideation (Velting, 1999). Secondly, the trait of self-oriented perfectionism (i.e., setting high personal standards; note the distinction from socially prescribed perfectionism that is associated with neuroticism), which overlaps conceptually with activation control, was shown to be negatively associated with depression (Flett, Russo, & Hewitt, 1994). Thirdly, activation control is partly operationalized in the ATQ in terms of control on procrastination. It has been shown that self-discipline and procrastination are highly (negatively) associated (Johnson & Bloom, 1995; Schouwenburg & Lay, 1995; Watson, 2001). Work by Lay and colleagues revealed that the aversiveness of the task was an important aspect of procrastination (Lay & Silverman, 1996), and that dejection rather
than anxiety resulted from procrastination (Lay, 1995). Together these findings suggest
that activation control, or the capacity to self-motivate for activities that have few
immediate incentives (cf. Cervone et al., 2006) is consistently associated with depression.
By extension, low activation control may, in addition to motivational beliefs that nothing
will change the situation anyway, underlie the association between depression and passive
coping strategies as well (e.g., Matheson & Anisman, 2003). Active coping, like activation
control, requires the execution and maintenance of a strategy that runs counter to more
easy and automated strategies (Derryberry, Reed, & Pilkenton-Taylor, 2003). Possibly,
then, the protective working of activation control is that an orientation towards action and
self discipline attenuates the possibility that small set-backs can get on top of one, as such
constraining the build-up of further sad affect and passive (and hence sadness enhancing)
coping strategies.

While of the same magnitude as in previous studies on the protective effects of
effortful control on emotional disorders, current effects are not strong. Although this is
not to say that small effects are unimportant (see Shiner & Caspi, 2003, for a clear account
of why not) we want to propose two causes as to why the effects of effortful control are
likely to be modest. The first cause has to with the complexity of self-regulation and its
measurement. As summarized by Derryberry and Tucker (2006), effortful control is only
one of many regulatory systems (involuntary attention, central arousal, motor, autonomic,
and endocrine systems) all of which influence one another as well as the motivational sub-
systems (the defense system or neuroticism, the appetitive system or extraversion) to
produce a highly variable behavioral outcome. Put differently, in the present research,
there are many unknowns within the individual apart from effortful control that exert their
influence. Moreover, research has indicated that the effects of temperament on
developmental outcome are rarely direct, but rather, in transaction with the environment
(e.g., family environment, life events) (Frick, 2004). Yet even if such contextual factors are
brought into the analysis, effects are likely to be small relative to experimental research
designs in which negative and positive incentive context can be manipulated and varied,
thereby fully gauging temperamental effects (cf. Nigg, 2006). While we currently
speculated on the process of how the effects of voluntary attentional, inhibitory, or
activation control may take place (e.g., voluntary attentional disengagement, free working
memory space for extra oversight, self-discipline and action for defying depression build-
up), such mechanisms can be captured directly in experimental designs, presumably with
larger effects.

Secondly, we want to point out a possible cause as to why effects are small for
anxiety and depression relative to effects reported for externalizing disorders. It has been
argued convincingly that all questionnaire measures of effortful control as well as
laboratory executive functioning tasks comprise aspects of executive processes, involving
the flexible control of behavior, and aspects of reactive processes, involving reactive
behavior motived by emotions such as fear (Nigg, 2000; Nigg et al., 2005). On a
predominantly motivational measure the prediction would be that anxious or depressive
individuals have higher scores than individuals from an unaffected comparison group (for
example, Kochanska, Coy & Muray [2001] found a positive association between reactive
behavioral inhibition [i.e., children suppressed behavior in line with prohibitions by their
mother] and fearfulness). In contrast, as was hypothesized in this paper, anxious and
depressive children would have lower scores relative to an unaffected comparison group
on a predominantly executive measure. Thus, in individuals with internalizing problems,
executive and motivational control exert opposite influences, and the net effect on
measures that tap both aspects is uncertain. In individuals with externalizing problems,
however, the motivational (e.g., reduced reactive inhibition such as loosing temper) and
voluntary executive (e.g., reduced motor inhibition) components of a measure work in
tandem rather than in opposite directions. Thus, although Rothbart’s measure of effortful
control is thought to be primarily executive, some mixture of reactive and executive
control may nonetheless explain attenuation of the effects on anxiety of depression
relative to the larger effects found for externalizing disorders.

One important limitation of the present study is that we were unable to differentiate
cause and effect. On the one hand it is clear that individuals differ substantially in their
capacity of effortful control (Derryberry & Rothbart, 1997; Muraven & Baumeister, 2000;
Rothbart et al., 2003). Indeed, the starting point of the temperament approach and also of
the present study is that some people have a larger reservoir of effortful control than
others and hence that some people are less susceptible to maladjustment than others. On
the other hand, it is also well established that anxiety (Eysenck & Calvo, 1992) and
depression (Hartlage, Alloy, & Vázquez, 1993) reduce the available resources for executive
information processing. We regard it as likely that the reduced effortful control capacities
in individuals with high scores on anxiety and depression encompass both the influence of
cognitive control on emotional responses and the reverse effect of emotional states on
cognitive processes (Campos et al., 1994; Cole, Michel, & Teti, 1994; Fox 1994). Both may
play an important role in the chain of events towards the end result of a full-blown
disorder. For example, for depression-prone individuals, high on neuroticism and low on
extraversion, the self-regulatory challenge is to overcome these reactive tendencies of
having frequent negative emotional states and low incentive motivation. While individuals
with strong executive capacities in the face of some normal daily disappointment will be
able to disengage from the unattainable goal, refocus their attention, and take up the
pursuit of another incentive, the emotional state following disappointment may not be so
transient for individuals at risk for depression. They may remain more easily pre-occupied with the lost goal, and become less easily engaged in some distracting other activity that they like (Carver, 2004). This ruminative coping style (Nolen-Hoeksema, 1993) exhausts the already limited cognitive resources that could otherwise be used to effortfully step out of what is to become a downward spiral. The negative contents of their thoughts will prime other negative memories and amplify their passivity and eventually they may become chronically deficient in cognitive resources. Unable to put over the helm, they may abandon all effort, which precipitates a true depressive episode (Hartlage, Alloy, & Vázquez, 1993). A similar chain of cause and effect could be described for anxiety. Obviously, the dynamic nature of such proposed downward spirals could not be tested in the present research. It requires a longitudinal design with much more dense measurement than used here, such as by the experience sampling method (cf. Caprara & Cervone, 2000, p. 333).

A second limitation with regard to our findings is the reliance on self-report measures. This brings along a certain amount of method bias. For measurement of intrapsychic characteristics such as neuroticism or anxiety/depression, other-report is suboptimal relative to self-report. This may even hold for effortful control, in particular attentional control, also not easily observed by others (Eisenberg et al., 2005a). Clearly, the inclusion of objective laboratory measures of (sub-components of) effortful control in future studies would constitute an important addition to self-report measures.

A third limitation is the following. Despite the need for parsing effortful control into more homogenous sub-components (Derryberry & Tucker, 2006; Eisenberg et al., 2005a; Nigg, 2000; Nigg et al., 2006), their theoretical separateness (Cervone et al., 2006; Derryberry, 2002; Evans & Rothbart, 2007), and their relatively low intercorrelations (see Table 2), it is nonetheless uncertain if the current subdivision into attentional, inhibitory, and activation control is the most valid sub-division, and if these three traits are exhaustive. Discussion as to how sub-components of temperamental effortful control map unto facets of conscientiousness in the Big Five personality model, and unto different executive functioning capacities as differentiated in the cognitive literature, has yet to take place.

A fourth limitation concerns the possible limited generalization of our findings beyond a familial high-risk population. Children of parents with an anxiety or mood disorder are at high risk for developing psychiatric problems through inherited biological vulnerabilities and more than average exposure to varying environmental risks (e.g., parental discord, lack of warmth) (Goodman & Gotlib, 1999). In a similar vein, strong effortful control capacities have a partial genetic basis and partly develop in interaction with a supportive environment (Eisenberg et al., 2005b). Such findings illustrate an
important asset of our study, that is, our high-risk design ensures the maximum possible variance on both etiological and outcome measures. However, a drawback of this high-risk design is that it is in principle possible that our sample identifies susceptibility or protective factors that do not, or play a different role, in the general population. Given these limitations, current findings clearly await replication.

The present results inform treatment because successful treatment of psychopathology requires the ability to self-regulate (Dale & Baumeister, 1999). For example, cognitive therapy involves gaining control over reactive, automated patterns of negative thought (Derryberry, 2002). Similarly, the learning of more adaptive coping strategies requires the activation and sustenance of difficult and tedious behaviors (Derryberry et al., 2003). It has been shown that through training, such effortful control capacities can be strengthened (Rueda et al., 2005; Wells & Matthews, 1994). In fact, they are likely more amenable to change than the reactive temperament traits of neuroticism and extraversion. Apart from training voluntary control, adaptive environmental stimuli to attend to in situations where automatic negative processing predominates need to be learned (Derryberry & Tucker, 2006; Segal, 1996). Thus, the strengthening of effortful control capacities along with a focus on how these can be applied in different situations provide a feasible handle for successful intervention.