TRAIT WORRY PREDICTS EMOTIONAL INTERFERENCE DURING THE EMOTIONAL STROOP TASK IN ADOLESCENCE

by

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ABSTRACT

Introduction: Adolescents face a particular vulnerability to the onset of internalizing disorders, which past research has linked to numerous health risks and negative outcomes. Trait worry is a transdiagnostic factor closely linked to internalizing pathology, which has been associated with differences observed in cognitive control processes in past studies of adult populations. The aim of the current study is to examine the potential relationship between trait worry and emotional interference during a cognitive control task in a population of adolescents. We hypothesized that higher levels of trait worry would be associated with better performance on negative vs. positive word trials, reflecting decreased inhibition of attention to negative information.

Methods: The final sample for this study consisted of 67 adolescents (25 male, 42 female), ages 11 to 14 (M = 12.26, SD =1.02), who completed several self-report measures and an emotional Stroop task. A partial correlation analysis was performed between PSWQ-C total scores and emotional interference scores during the emotional Stroop task.

Results: Findings indicate a significant correlation between trait worry and emotional interference during the emotional Stroop task, such that higher levels of trait worry were associated with more accurate identification of negatively valenced words, while lower levels of trait worry were associated with more accurate identification of positively valenced words.

Limitations: These results should be interpreted within the context of several limitations, including a modest sample size and the use of self-report measures to determine pubertal status and trait worry.

Conclusions: The findings of this study indicate a difference in cognitive control processes present in adolescents with trait worry, which may inform a more in-depth understanding of the early determinants associated with internalizing pathology.

Chapter 1

INTRODUCTION

Adolescence is a period of development characterized not only by a myriad of social and biological changes, but also by heightened risk for the development of psychological disorders, particularly internalizing disorders (Ladouceur et al., 2012). Internalizing disorders (e.g., generalized anxiety disorder, obsessive compulsive disorder, social anxiety disorder) represent a significant health risk to adolescent populations in the U.S.. Indeed, individuals aged 13 or older experience a 9.0% lifetime morbid risk for developing generalized anxiety disorder (Kessler et al., 2012). These disorders are highly comorbid, and frequently appear in conjunction with other psychopathological issues (i.e., suicidality, substance use, behavioral disorders) (Liu et al., 2011). Internalizing disorders are also linked to long-term adversity, as adolescents diagnosed with an anxiety disorder experience a 2- to 3-fold increase in likelihood of being diagnosed with an internalizing disorder during adulthood (Pine et al., 1998). Examining the presentation of internalizing pathology in early adolescence may also elucidate early determinants for the emergence of internalizing disorders. Identification of such determinants would prove especially relevant to adolescent populations, given the particular vulnerability to internalizing disorder onset which they face.

Worry, a cognitive style which involves excessive, distressing, and uncontrolled thoughts about the future, is a transdiagnostic factor posited to confer risk

for multiple internalizing disorders (Drost et al., 2014; Hall et al., 2019; Wahl et al., 2019). Uncontrollability of worry has been linked to negative outcomes, including comorbidity and an increase in internalizing disorder severity (Hallion et al., 2014). Given the increased vulnerability towards internalizing disorder onset which adolescents face, along with the established link between worry and pathology, it is important to examine trait worry as it relates to pathology and cognitive control processes in adolescence. The patterns of cognition that characterize worry, which are typically future-oriented and focused on the potential for adverse outcomes in a given situation, are associated with impaired attention and the intrusion of unwanted thoughts (Hallion et al., 2017). The intrusive and uncontrollable nature of worry may be related to differences in cognitive control processes, including impairments in inhibition and concentration (Tempesta et al., 2013).

Adolescence represents a period critical to the development of cognitive processes, including cognitive control (Miyake et al., 2000). Cognitive control encompasses three interrelated components: shifting (the ability to switch between different task sets), working memory (the ability to process and keep new, salient information in one's mind), and inhibition (the ability to override a dominant, but irrelevant response to a stimulus in favor of a non-dominant, task-relevant response) (Hallion et al., 2017). Prior research has demonstrated a link between generalized anxiety disorder and increased inhibition in the "cold" (non-emotional) Stroop task, but found that trait worry does not predict non-emotional inhibition (Hallion et al., 2017). However, less is known about the relationship between trait worry and

emotional inhibition during the “hot” (emotional) Stroop. Given the previously investigated association between inhibition and pathology, and the heightened emotional reactivity which is often present during adolescence, it is important that we examine trait worry (a transdiagnostic factor associated with internalizing pathology and cognitive control differences) in relation to emotional interference.

One way to assess cognitive control is by administering the Stroop task, which measures an individual’s ability to process and distinguish between task-relevant and task-irrelevant information (Egner & Hirsch, 2005). An emotional variant of the Stroop task assesses cognitive control capabilities within the context of emotion, and may in turn provide insight into the association between cognitive control and worry-related pathology (e.g., generalized anxiety disorder) (Banich et al., 2019). Performance on the emotional Stroop task can be interpreted in terms of either reaction time, reflecting efficiency of task performance, or accuracy, reflecting effectiveness of task performance (Hallion et al., 2017). Prior research has demonstrated that the accuracy and reaction time of an individual’s responses may be linked to several internalizing problems, including state anxiety (Dresler et al., 2009) as assessed by the State-Trait Anxiety Inventory (STAI) (Laux, 1981). Specifically, state anxiety was associated with increased accuracy in recognition and recall of emotional words (regardless of valence) in comparison with neutral words in a population of adults (Dresler et al., 2009). However, it is unclear whether *trait* worry relates to accuracy in a similar way, or if this association exists at all in early adolescence.

Past research has demonstrated that response accuracy during a cognitive control task varies with pubertal status, with preadolescent children exhibiting longer response times and giving less accurate responses than their more developmentally advanced counterparts (Wu et al., 2011). Additionally, there has been a broad range of variability in the results of studies examining the interaction between accuracy and reaction time, with some indicating that a decrease in reaction time associated with maturation is linked to an increase in accuracy (Rebok et al., 1997), while others suggest that advancing developmental status may be associated with greater impulsivity and decreased inhibition, resulting in decreased accuracy (Davidson et al., 2006). These inconsistencies underscore the importance of examining accuracy as a measure of performance on cognitive control tasks, particularly when considering the degree of emotional reactivity and impulsivity largely inherent to adolescent populations (Wu et al., 2011).

Chapter 2

PRESENT STUDY

To assess the association between trait worry and emotional interference, we administered an emotional variant of the Stroop task in which early adolescents were required to determine the emotional valence (i.e., negative, positive) of a task-relevant word when viewed in conjunction with an emotional face, which was either congruent or incongruent to the valence of the word (Banich et al., 2019). We examined how performance on the emotional Stroop differed when participants classified negative versus positive words via an interference score, in which the percent accuracy when classifying positive words was subtracted from that of negative words. Thus, the interference score indexed the net difference between accuracy in positive and negative word trials, such that a negative score indicates greater accuracy during positively valenced word trials, while a positive score indicates greater accuracy during negatively valenced word trials.

Given our understanding that internalizing disorders frequently develop during adolescence and are associated with significant health risks, it is important to elucidate indicators which may serve as early determinants of these disorders. Examining the relationship between internalizing pathology and cognitive control in an early adolescent population may uncover factors which contribute to the development of internalizing disorders, and inform a more complete understanding of internalizing disorder onset and progression. While past work has investigated the link between

worry and cognitive control, this is the first study to our knowledge which has examined, in a population of adolescents, emotional interference in relation to trait worry. Based on the findings of past work, we expected that greater levels of trait worry would be associated with better performance on negative vs. positive word trials.

Chapter 3

METHODS

Participants.

A total of 120 adolescents completed a series of questionnaires and a neuroimaging scan as part of a larger ongoing study. Individuals between the ages of 11 and 14 who were fluent in English were eligible for recruitment into this study. Exclusion criteria included magnetic resonance imaging (MRI) contradictions (i.e., metallic implants), and history of a head injury with lasting impact. Advertisements encouraged participation from individuals who had anxiety or family members with anxiety, and thus internalizing symptoms are well-represented in the study sample. Both adolescents and one of their biological parents participated in the study.

We excluded 53 participants with accuracy scores of less than 60%, based on the assumption that they had not properly understood the task. The final sample consisted of 67 adolescents (25 male, 42 female), ages 11 to 14 (M = 12.26, SD =1.02).

Measures.

Pubertal Status: Participants completed the Pubertal Development Scale (PDS) (Petersen et al., 1988), a self-report measure which consists of five items regarding body hair growth, skin changes (i.e., acne), occurrence of a growth spurt, menarche and breast development in girls, and voice-deepening and facial hair growth in boys

(Chan et al., 2010). Participants were instructed to answer these questions about their development using a 4-point rating system (*1 = has not yet begun, 2 = has barely started, 3 = is definitely under way, and 4 = growth or development is complete*) (Robertson et al., 1992). Female participants were also asked to report whether they had started to menstruate dichotomously (yes/no), and, if so, provide the age at which menstruation first began. Total PDS scores were calculated in girls as the sum of responses to questions regarding breast development, body hair growth, and menarche; and in boys by totaling body hair growth, facial hair growth, and voice-deepening responses.

Worry: Participants completed the Penn State Worry Questionnaire for Children (PSWQ-C), a 14-item self-report measure which assesses the severity of trait worry (Muris et al., 2001). The PSWQ-C prompts participants to self-rate the veracity of a series of statements regarding their worrying habits (e.g., "when I am under pressure, I worry a lot" and "I know I shouldn't worry, but I just can't help it") using a scale ranging from 0 ("not at all true") to 3 ("always true") (Muris et al., 2001). Total PSWQ-C scores were calculated as the sum of a participant's responses to all 14 items, with higher total scores indicating a greater level of trait worry.

Emotional Interference: Participants completed an emotional Stroop task to obtain a behavioral measure of individual differences in cognitive control capabilities in an affective context (Banich et al., 2019). Participants were shown images from 16 different posers (8 female; 8 male) drawn from the NimStim Set of Facial Expressions (Tottenham et al., 2009). Two images from each poser were used: one exhibiting a

negatively valenced “sad” facial expression, the other exhibiting a positively valenced “happy” facial expression. Each image was accompanied by a positively or negatively valenced word (e.g., joy, sorrow) which was either congruous or incongruous with the valence of the facial expression depicted in the image. Participants were presented with a series of emotion word-emotional face combinations, both congruous and incongruous, and instructed to identify the valence of the word they were viewing by pressing one of two buttons (Banich et al., 2019). Task accuracy was calculated in order to index a participant’s ability to process task-relevant (emotion word) and task-irrelevant (emotional face) information. Emotional interference scores were calculated as the difference between accuracy of responses given for negative and positively valenced words.

Data Analysis.

To examine the relationship between worry and cognitive control in adolescents, we performed a partial correlation analysis between PSWQ-C total scores and emotional interference scores during the emotional Stroop task. Additionally, considering that both trait worry and cognitive control vary as a function of pubertal status, we controlled for PDS total score in order to isolate the relationship between worry and cognitive control.

Chapter 4

RESULTS

Trait Worry and Interference.

When controlling for PDS total scores (M = 10.96, SD = 4.14) in a partial correlation analysis, we observed a moderate (r = 0.262) but significant (p = 0.038) correlation between PSWQ-C total scores (M = 17.47, SD = 10.53) and emotional interference scores (M = -0.0047, SD = 0.04016). These results indicate the existence of a significant relationship between trait worry and emotional interference during the emotional Stroop task, such that as trait worry increases, participants more accurately identify negative words, and as trait worry decreases, participants more accurately identify positive words.

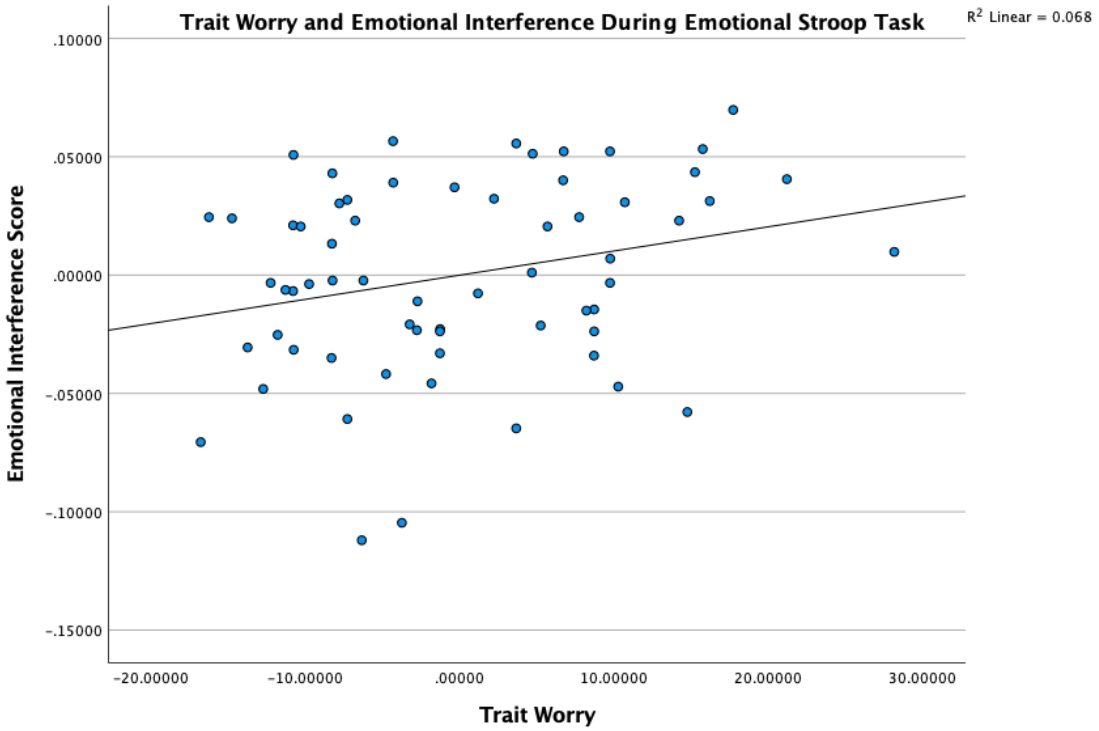

Figure 1. Correlation between trait worry and emotional interference. Graph reflects values with pubertal status partialled out.

Chapter 5

DISCUSSION

Previous studies have examined the association between internalizing issues and performance on the emotional Stroop task. However, this is the first study to our knowledge which has examined, in a population of adolescents, the relationship between trait worry and emotional interference during an emotional Stroop task. In order to further our understanding of this association, we examined whether emotional interference varies as a function of trait worry. Findings revealed a significant correlation between emotional interference scores and worry when controlling for pubertal status, such that as trait worry increases, participants more accurately identify negative words and as trait worry decreases, participants more accurately identify positive words.

Findings from this study suggest that an individual's accuracy when identifying emotionally valenced words relates to trait worry, a factor associated with internalizing pathology. These findings align with a previous study, which linked high trait anxiety to emotional interference during the emotional Stroop task in young adults (Kamboureli & Economou, 2021). Interestingly, this effect observed in young adults (ages 20-30) was not present in older adults (ages 60-70) who also reported high trait anxiety. When considered alongside those from the current study, these results may identify emotional interference as a correlate of internalizing pathology which is specific to early adolescence and young adulthood, and may thus serve as an

early determinant of internalizing disorders. Our findings are also consistent with those from past studies of adults, which have linked trait worry to increased interference (Dresler et al., 2009) during cognitive control tasks. Given the limited amount of work which has previously examined this relationship in adolescent populations, additional research is needed to further explore the association observed in this study.

Current results should be interpreted within the context of several limitations. First, the sample size for this study was relatively limited, and contained significantly more female than male participants. Second, self-report measures were used to assess both pubertal development and trait worry. These types of measures are inherently subject to reporter biases, however, past work has demonstrated that the PDS and PSWQ-C are reliable indicators of pubertal development and trait worry, respectively (Bond et al., 2006; Muris et al., 2001). Future studies with larger sample sizes should seek to replicate our findings through the use of more direct measures, including physical examinations and psychometric evaluations. Despite these limitations, our study had a number of strengths: most notably, a group of socioeconomically and ethnically diverse participants in which trait worry was robustly represented.

Altogether, these results provide evidence of a link between trait worry and emotional interference during the emotional Stroop task in adolescence. These findings may indicate a difference in cognitive control processes present in adolescents with trait worry, which may in turn represent an early determinant of

internalizing disorders. Given the limited body of prior research into this association, additional research is needed to further explore the relationship observed in this study.

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