UNIVERSITY OF CALIFORNIA, SAN DIEGO

SAN DIEGO STATE UNIVERSITY

Performance-Based Cognitive Processing in Clinically Anxious Youths

A dissertation submitted in partial satisfaction of the
requirements for the degree of Doctor of Philosophy

in

Clinical Psychology

by

Michelle Sherry Rozenman

Committee in charge:

University of California, San Diego

Professor Catherine Ayers
Professor Ann Garland
Professor Murray Stein

San Diego State University

Professor V. Robin Weersing, Chair
Professor Nader Amir, Co-Chair
Professor Elizabeth Klonoff

2013

The Dissertation of Michelle Sherry Rozenman is approved, and it is acceptable in quality and form for publication on microfilm and electronically:

_____

_____

_____

_____

_____

_____
Chair

University of California, San Diego

San Diego State University

2013

DEDICATION

This dissertation and my doctoral training were immeasurably guided by the scientific support, and professional and personal development, of my primary advisor, Dr. V. Robin Weersing. Robin, your mentorship has shaped me into the clinical scientist that I am today and will become tomorrow. Thanks to Dr. Nader Amir, my secondary advisor and co-Chair of this dissertation, for teaching me about cognitive bias theory, data collection, and analysis, and providing the materials and guidance for my study of cognitive bias assessment and intervention with youths. To Robin and Nader collectively, for agreeing to a joint mentorship model and laying the foundation for my work. I am extremely grateful to the children and families who contributed to my clinical training experiences and helped to make my independent line of graduate research possible.

I would like to thank Drs. Murray Stein, Catherine Ayers, Ann Garland, May Yeh, Joseph Price, Sandra Brown, and all of the faculty and staff at the SDSU/UCSD Joint Doctoral Program in Clinical Psychology for their contributions to my development as a clinician and researcher. I would also like to thank the members of ChAAMP lab and my graduate student colleagues at the JDP, who helped to make my years in graduate school and San Diego a home away from home.

Last, but always first in my heart, are my family and friends who provided unconditional love and support during my doctoral training. I am especially thankful to my parents, who sacrificed to raise me in such a way that I never knew want and always encouraged me to follow my dreams. And to my friends, the inner circle who make me more me.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

VITA

2005	Bachelor of Arts, University of California, Los Angeles
2005-2007	Research Coordinator, University of California, Los Angeles
2009	Master of Science, San Diego State University
2012-2013	Predoctoral Psychology Intern, UCLA Semel Institute for Neuroscience and Human Behavior
2013	Doctor of Philosophy, San Diego State University and University of California, San Diego, Joint Doctoral Program in Clinical Psychology

PUBLICATIONS

Riemann, B. C., Kuckertz, J. M., Rozenman, M., Weersing, V. R., & Amir, N. (*in press, Depression and Anxiety*). Augmentation of cognitive behavioral and pharmacological interventions with attention modification in youths: A randomized placebo controlled trial.

Weersing, V. R., Rozenman, M., Maher-Bridge, M., & Campo, J. (2012). Anxiety, depression, and somatic distress: Developing a transdiagnostic internalizing toolbox for pediatric practice. *Cognitive and Behavioral Practice, 19*, 68-82.

O'Neill, J., Piacentini, J. Chang, S., Levitt, J., Rozenman, M., Bergman, R. L., Salaman, N., Alger, J., & McCracken, J. (2012). MRSI correlates of cognitive-behavioral therapy in pediatric obsessive compulsive disorder. *Progress in Neuro-Psychopharmacology & Biological Psychiatry, 36*, 161-168.

Woods, D. W., Piacentini, J. C., Scahill, L., Peterson, A. L., Wilhelm, S., Chang, S., Deckersbach, T., McGuire, J., Specht, M., Conelea, C. A., Rozenman, M., Dzuria, J., Liu, H., Levi-Pearl, S., & Walkup, J. T. (2011). Behavior therapy for tics in children: Acute and long-term effects on psychiatric and psychosocial functioning. *Journal of Child Neurology, 26*, 858-865.

Rozenman, M., Weersing, V. R., & Amir, N. (2011). A case series of attention modification in clinically anxious youths. *Behaviour Research and Therapy, 49*, 324-330.

Weersing, V. R., Rozenman, M., & Gonzalez, A. (2009). Core components of therapy in youth: Do we know what to disseminate? *Behavior Modification, 33*, 24-47.

ABSTRACT OF THE DISSERTATION

Performance-Based Cognitive Processing in Clinically Anxious Youths

by

Michelle Sherry Rozenman

Doctor of Philosophy in Clinical Psychology

University of California, San Diego, 2013
San Diego State University, 2013

Professor V. Robin Weersing, Chair
Professor Nader Amir, Co-Chair

Anxiety is distressing, impairing, and the most prevalent mental health problem in children and adolescents. Theoretical models implicate biases in cognitive processes as underlying the development and maintenance of anxiety disorders. Yet little work has

been done to test theoretical models of information processing (IP) in clinically anxious youths. The present dissertation sought to examine relationships between youth anxiety and the basic cognitive processes of attention and interpretation using performance-based methodology. The aims of this investigation were to: 1) empirically test the IP model of youth anxiety, specifically whether biased interpretation statistically mediates the association between biased attention and anxiety symptoms, 2) unpack the components of interpretation (i.e., threat valence judgments, speed of responding) on a performance-based task of interpretation bias, and 3) probe the impact of comorbid depressive symptoms on these cognitive processes.

Youths (N=26, ages 9 to 17) and their primary caregivers completed diagnostic interviews and a comprehensive self-report battery, and youths completed performance-based assessments of attention and interpretation. In this sample, attention bias towards threat was significantly associated with percentage of negative interpretations endorsed (r=.46, p=.019). However, attention was not significantly related to anxiety symptoms, and the indirect effect of attention on anxiety through interpretation was not statistically significant. Negative interpretations of ambiguous information strongly predicted youth anxiety symptom severity, accounting for 46% of variance in clinician-rated anxiety severity. Deconstructing interpretation into its components, youth response latencies on the interpretation task as measured by threat and benign reaction time indices were not significantly associated with attention. Percentage of negative interpretations endorsed (r=.68, p<.001) and response latencies on the interpretation threat reaction time index (r=.45, p=.022) were significantly related to anxiety severity. Conversely, response latencies on the benign interpretation reaction time index were not related to anxiety.

Finally, depressive symptoms were not significantly related to attention or to any of the components of interpretation assessed in this sample of clinically anxious youths.

These findings provide preliminary evidence for a relationship between attention and interpretation biases, and stronger evidence for a relationship between interpretation bias and anxiety. Clinical and theoretical implications of this study are discussed.

INTRODUCTION

Anxiety disorders are disabling, distressing, and the most prevalent mental health problem in children and adolescents (25%; Beesdo, Knappe, & Pine, 2009; Bell-Dolan, Last, & Strauss, 1990; Schaffer, Fisher, Dulcan, & Davies, 1996). Untreated anxiety predicts continuation of anxious symptoms (Dadds, Holland, Laurens, Mullins, Barrett, & Spence, 1999; Roza, Hofstra, van der Ende, & Verhulst, 2003) and other negative long-term outcomes, such as social isolation, academic underachievement, poor physical health, and substance dependence (Bittner, Egger, Erkanli, Costello, Foley, & Angold, 2007; Woodward & Fergusson, 2001).

Theoretical models of youth anxiety implicate the role basic cognitive processing biases as underlying mechanisms in the development and maintenance of anxiety disorders (e.g., Crick & Dodge, 1994; Daleiden & Vasey, 1997; Muris & Field, 2008). These information processing (IP) models seek to explain the underlying cognitive components of anxiety expression by providing a framework for the ways in which anxious individuals encounter and process stimuli in the environment. Although specific details may vary, classic IP models include a series of five cognitive, followed by one behavioral, steps: (1) encoding or attending to external and internal stimuli, (2) interpretation and mental representation of stimuli, (3) clarification or selection of goals related to the stimuli, (4) access and construction of responses for these goals, (5) response decision, and (6) response enactment, or behavioral expression of internalizing problems. Much of the IP literature focuses on how these first two stages of attention and interpretation (e.g., Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & Van

Ijzendoorn, 2007) might be related to internalizing symptoms, utilizing individuals' self-reports of symptoms as a proxy for the sixth stage of IP (i.e., response enactment).

Figure 1 provides a heuristic model of IP in youths, with a descriptive example of how the cascading effects of information processing may play out in a youth with social phobia. Biased processing may begin with an early attention to and interpretation of stimuli that is perceived by the youth to be threatening (e.g., selectively attending towards a frowning face at a social event may lead to negative interpretations of others' judgments about self) and continue through higher levels of processing until the youth eventually engages in avoidance or other maladaptive behaviors.

Information Processing Stage	Description of Stage	Clinical Phenomena*
Attention	Initial focus on environmental stimuli	Only notices frowning faces at a social event
Interpretation	Ambiguous information appraised for meaning	Interprets others' laughter as making fun of self
Goal Clarification / Selection*	Goal selected for response to stimuli	Wants to escape from social situation to avoid others
Response Access / Construction*	Cognitive / behavioral responses appraised	Evaluates possible means escape (e.g., finding parent, leaving room)
Response Decision	Cognitive / behavioral response selected for implementation	Selects means of escape avoidance, such as finding parent
Enactment	Behavioral response enacted	Asks parent to leave social setting because "stomach hurts"

Note: *A description of the cascading effects of biased information processing using Social Phobia as an example.

Figure 1. An Heuristic Model of Information Processing (IP)

Broadly, anxiety has been linked empirically with several cognitive features, including hypervigilance and selective attention towards threat (Bradley, Mogg, Falla, & Hamilton, 1998; Daleiden & Vasey, 1997; Mathews & MacLeod, 2005), rumination and worry (Chelminski & Zimmerman, 2003), and inaccurate appraisal (Ingram, 1989). Furthermore, the dominant evidence-based interventions (e.g., cognitive-behavioral therapy; CBT) for anxious adults and youths target these cognitive processes as a core feature of disorder. Despite this focus on cognition, the youth anxiety literature lags far behind the adult studies in (a) developing a knowledge base focusing on specific components of biased information processing, and (b) utilizing speeded performance-based measures designed to assess cognitive processes that are proposed to occur early in the IP chain. Additionally, most research with youth samples focuses on the relationship between anxiety and a single proposed cognitive process, with very little empirical study of the links, or relationships between cognitive processes, in the IP chain.

This dissertation seeks to fill these gaps in the literature by assessing the links between attention bias, interpretation bias and anxiety symptom severity in youths using performance-based assessments of these early cognitive processes. The experiences of anxious youths are proposed to iteratively inform continued selective attention towards threat and interpretation of stimuli as negative through learning, with past avoidance experiences informing future processing of information in ways that maintain psychopathology (e.g., Puliafico & Kendall, 2006). Thus, these first two early processes – selective attention towards threat and negative interpretations of ambiguous stimuli – may be particularly critical for both the development and the maintenance of psychopathology through the cascading and iterative effects of the IP chain. As reviewed below, an

abundance of empirical investigations in have supported that attention biases towards threat and negative interpretations of ambiguous information may play a key role in anxiety disorders in adults (e.g., Mathews & MacLeod, 2005; Muris & Field, 2008); however, data on youth are less available and results more ambiguous.

Another potentially important factor in the investigation and accurate assessment of anxious cognitive processing is the presence of depressive symptoms or diagnoses. The level of comorbidity between anxiety and depression in youth is quite high. Ten to fifteen percent of youths with a primary anxiety disorder will be concurrently depressed; these rates increase when including youths with significant subsyndromal symptoms of depression (Angold, Costello, & Erkanli, 1999). Furthermore, depressed adolescents seeking services are extremely likely to meet for current or past history of anxiety disorder, with rates ranging from 70% to 85% in community clinic and primary care samples (Birmaher et al., 1996). These data, and longitudinal investigations of internalizing families, have led researchers to suggest that the "typical" developmental trajectory of internalizing problems may begin with childhood anxiety, followed by onset of first depressive episode in early adolescence, and subsequent recurrent episodes of comorbid depression and anxiety throughout adulthood (Keller, Lavori, Wunder, Beardslee, Schwartz, & Roth, 1992; Dadds et al., 1999; Reinherz, Giaconia, Hauf, Wasserman, & Silverman, 1999). Accordingly, in the review of attention and interpretation findings across the adult and youth anxiety literatures, depression is discussed where it may be particularly relevant to specific expressions of basic cognitive processes.

BACKGROUND

Attention

Biased attention in adults. In anxious adults, the IP literature is fairly consistent in the demonstration of biased attention toward threatening stimuli (Mogg & Bradley, 2005). Clinically-anxious individuals exhibit an early and automatic (i.e., at 500 milliseconds [ms]) biased attention towards threat (e.g., Bar-Haim et al., 2007; Mathews & MacLeod, 2005; Mogg & Bradley, 2005), slow disengagement from threat when stressed (Ellenbogen & Schwartzman, 2009), and exaggerated negative emotional reactivity for threat stimuli (Gotlib, Krasnoperova, Yue, & Joormann, 2004). These anxiety findings contrast with patterns in the adult depression literature, which suggest a slower engagement of attention to negative stimuli (i.e., 1000 ms), with a bias toward emotional (e.g., sad) rather than physical or social threat (Mogg & Bradley, 2005; Gotlib et al., 2004). The adult literature also implicates attention bias as a mediator between various self-reported measures of anxiety and anxious reaction to mood or stress induction tasks (e.g., Taylor, Bomyea, & Amir, 2010). Further evidence for the central role of biased attention in adult anxiety are the findings from cognitive bias modification (CBM) studies, which specifically manipulate attention away from threatening stimuli, resulting in reduction of both anxiety symptoms and attention bias towards threat (for review, see Hakamata, Lissek, Bar-Haim, Britton, Fox, Leibenluft, & et al, 2010). Even more compelling evidence that attention plays a causal role in anxiety comes from these attention modification trials; attention bias reduction mediates the relationship between baseline attention bias and anxiety symptom reduction (e.g., Amir, Beard, Cobb, & Bomyea, 2009).

Biased attention in youths. Youth studies have produced far less consistent findings across IP paradigms and anxiety disordered youths. Some studies suggest that both anxious and non-diagnosed control youths show similar attention to threat and neutral stimuli (Kindt, Brosschot, & Everaerd, 1997; Waters, Lipp, & Spence, 2004). Other studies show differentiation in bias where anxious youths attend to threat but controls do not (Roy, Vasa, Bruck, Mogg, Bradley, Sweeney, & et al., 2008). Additionally, while anxious youths have been shown in some investigations to attend to both threat and dysphoric stimuli (Waters & Lipp, 2008), other findings suggest biased attention only towards threat (but not dysphoric) stimuli (Dalgleish, Taghavi, Neshat-Doost, Moradi, Canterbury, & Yule, 2003; Taghavi, Neshat-Doost, Moradi, Yule, & Dalgleish, 1999). There has also been inconsistency in regards to whether all children (Waters, Henry, Mogg, Bradley, & Pine, 2010), only anxious children (Waters et al., 2004), or only anxious children with very high disorder severity ratings (Waters, Mogg, Bradley, & Pine, 2008) demonstrate selective attention for positive pictures or happy faces. Conversely, some findings indicate that no youths (anxiety disordered or controls) demonstrate biases to positive stimuli (Roy et al., 2008; Waters, Mogg, Bradley, & Pine, 2011). Finally, findings are again variable in demonstrating associations between attention bias and anxiety when researchers modify performance-based tasks by increasing stimuli presentation latencies in attempts to ensure that youths are developmentally able to attend to stimuli (e.g., using 1250 or 1500 ms; Hunt, Keogh, & French, 2007; Kindt et al., 1997).

This picture is further complicated by comorbidity. Some studies have found that comorbid anxious/depressed and primarily depressed youths do not demonstrate a “typical” anxious threat bias (Taghavi et al., 1999; Neshat-Doost, Moradi, Taghavi, Yule, &

Dalgleish, 2000), while others suggest that these groups demonstrate bias towards depressive stimuli comparable to the bias exhibited by anxious youths to threat (Dalgleish et al., 2003; Ladouceur, Dahl, Williamson, Birmaher, Ryan, & Casey, 2005). Moreover, the majority of investigations with youths do not describe the level of depression in their samples, leaving open the possibility that variability in results across studies may be due to systematic, but unmeasured, comorbidity. Despite this variability between studies, meta-analyses of the attention literature indicate that, overall, anxious youths exhibit similar attention biases to threat as adults (Bar-Haim et al., 2007). The literature acknowledges these between-study differences, and calls for additional work to better understand attention bias in youths with clinical levels of anxiety (e.g., March, 2011).

The youth anxiety area has begun to adopt attention bias modification programs, originally used to treat adult anxiety, for youths, with two published studies in samples of clinically anxious youths. In a case series conducted by this author and her mentors, we demonstrated that, while anxiety significantly decreased over the course of attention modification, attention bias did not significantly change from pre-to-post treatment, nor did it mediate the relationship between initial attention bias and anxiety symptom reduction (Rozenman, Weersing, & Amir, 2011). A closer examination of the attention data revealed variability in bias scores at both baseline and post-treatment, with some youths biased towards threat, some biased towards neutral, and some demonstrating no biases (in comparing reaction times for threat and neutral faces). Another published attention modification trial preselected clinically anxious youths who only demonstrated "severe" attention bias, or bias towards threat significantly different from zero (Eldar, Apter, Lotan, Perez Edgar, Naim, Fox, & et al., 2012). While anxiety symptoms significantly

decreased, and overall there was a trend toward changes in attention bias in the attention modification treatment condition, no mediating role for attention was established. Therefore, while this work provides support for treating youth anxiety through attention bias modification, attention has not yet been demonstrated as the mechanism of change that accounts for treatment effects in youths.

Interpretation

Biased interpretation in adults. In IP models, interpretation is the second stage of cognitive processing, proposed to occur immediately after attention (Daleiden & Vasey, 1997; Crick & Dodge, 1994). Studies with adults have found that anxious individuals favor negative interpretations (via self-report or vignette ratings; Huppert, Foa, Fur, Filip, & Mathews, 2003; Stopa & Clark, 2000) and lack a benign interpretation bias (Constans, Penn, Ihen, & Hope, 1999; Hirsch & Mathews, 2000), as compared to non-diagnosed controls. Questionnaire studies of negative interpretations in adults have shown negative interpretations to mediate the effect of social anxiety on state anxiety (e.g., Beard & Amir, 2010). Studies of performance-based interpretation have also demonstrated that, in addition to making more negative interpretations, anxious adults demonstrate faster reaction times when making threatening, versus neutral, interpretations than non-anxious controls (e.g., Amir, Beard, & Przeworski, 2005). This suggests that anxious individuals' quick responses to ambiguity with negative attributions may be automatic or difficult to inhibit, as compared to a relative slower speed of assigning benign attributions. CBM studies have shown that training interpretation towards benign attributions decreases attention bias towards threat (e.g., Amir, Bomyea, & Beard, 2010). The causal effects of interpretation on anxiety have also been demonstrated, with reductions in interpretation bias during

interpretation modification mediating the relationship between baseline interpretation bias and pre-to-post treatment anxiety symptom reduction (e.g., Beard & Amir, 2008). These findings suggest that the cognitive process of interpretation plays a role in maintaining anxiety and, interestingly, that its modification can cascade downward to impact attention, as well as upward to impact symptoms. The adult literature also suggests that later levels of processing may be implicated in depressive symptom presentation (see above); therefore, interpretation may be a particularly useful link in the IP chain in considering level of depressive symptom comorbidity within anxious samples.

Biased interpretation in youths. In the area of youth interpretation, the majority of published studies examine youth-reported negative self-statements (Schniering & Rapee, 2002; Stark, Best, & Adam, 1990), multiple choice selection of responses in interpretation of ambiguous vignettes (Barrett, Rapee, Dadds, & Ryan, 1996; Miers, Blote, Bogels, & Westenberg, 2008), and time-unlimited tasks, such as homophone identification (Waters, Wharton, Zimmer-Gembeck, & Craske, 2008) and in vivo selection of card stimuli (Hadwin, Frost, French, & Richards, 1997). These techniques do not necessarily target the early aspects of interpretation (i.e., under 3000 or 4000 ms), as self-reports of negative or "automatic" thoughts and time-unlimited tasks theoretically occur at slower, more controlled levels of processing within an IP framework (Crick & Dodge, 1994; Daleiden & Vasey, 1997). Conversely, basic interpretive processes are assumed to occur quickly and immediately after information is encoded, with individuals potentially unaware of the interpretations being made. It is likely that performance-based assessment of interpretation might provide information about youth cognitive biases that a self-reported (or other time-unlimited measures) might not provide, given that a) higher levels of processing may not

necessarily reflect automatic and fast interpretation and b) there is greater potential for response or social desirability biases that may impact youth performance on questionnaires asking them to indicate the content and frequency of negative thoughts.

A small number of studies have utilized performance-based interpretation paradigms with youths. In-Albon and colleagues (In-Albon, Dubi, Rapee, & Schnieder, 2009; In-Albon, Klein, Rinck, Becker, & Schnieder, 2008) developed and tested a novel pictorial assessment of interpretation, whereby youths responded to social- or separation-themed pictures. The measure appeared to demonstrate good initial reliability and validity, although in the second investigation (In-Albon et al., 2009), anxious youths did not interpret ambiguous pictures in a more negative way than non-anxious control youths. Another study of performance-based interpretations utilized a single-target implicit association test, with adolescent participants categorizing socially-relevant words as linked to positive or negative outcomes (de Hullu, de Jong, Sportel, & Nauta, 2011). In their study, adolescents endorsing high levels of social anxiety, as compared to those self-reporting low anxiety, indicated significantly more social cue words as related to negative outcomes. Although both of these tasks used performance-based assessment as a way of speeding youth responses to be more consistent with the conceptualization of interpretation as a basic, early and less-controlled process, neither study examined whether youths responded with differential speed depending on the stimuli presented. As described above, response latencies on performance-based tasks provide useful behavioral indicators of the comparative speed at which adults select threatening information to resolve ambiguity; these reaction time indices may also provide useful information about how anxious youths respond to ambiguous information in the environment. As with attention modification, the

child anxiety field has already moved towards cognitive bias modification of interpretation bias in clinical samples (to this author's knowledge, three small trials are currently being conducted). However, data are not yet available from intervention trials to support a causal role for interpretation in youth anxiety.

In addition, while some research has attempted to establish causal relationships between self-reported interpretation bias and anxiety, analytic models in these studies typically propose that internalizing symptoms predict cognitive biases (e.g., Hadwin et al., 1997). These studies provide valuable information about internalizing symptoms but the top-down approach may only reflect the iterative aspects of proposed IP models, whereby higher-order processes impact early processes through learning over time. Few studies have been conducted in which earlier processes predict later processes, although such empirical work may provide a more accurate portrayal of the bottom-up perspective of current youth anxiety IP models. Moreover, no published studies to date have attempted to assess relationships between performance-based attention and performance-based interpretation in youths, or examine whether youths make negative interpretations more quickly than benign interpretations. Because of these gaps in the literature, current knowledge about interpretation processes in youths is mostly extrapolated from adult investigations or from studies using negative self-statement questionnaires with youths.

Implications for empirical model specification and treatment development

A better understanding of the basic levels of information processing in anxious youths may provide empirical support for our theories of information processing, which in turn might provide theoretical clarification of disorder etiology. Several groups of researchers have called for clarification of divergent findings in the youth cognitive

process literature (March, 2011; Daleiden & Vasey, 1997; Puliafico & Kendall, 2006). Performance-based assessment of cognitive biases in this vulnerable period of development may provide critical knowledge about some of the mechanisms that may work as risk or protective factors in psychological functioning. For example, recent findings suggest that attention bias may predict youth treatment response to cognitive-behavioral intervention for anxiety, although the evidence is mixed about whether bias towards (Legerstee, Tulen, al., 2009) or away (Waters, Mogg, & Bradley, 2012) from threat predicts poorer treatment response.

Clarification of the roles played by basic attention and interpretation in the development and maintenance of youth anxiety disorders may also inform future intervention adaptations. Currently, the gold-standard evidence-based psychosocial intervention for the treatment of youth anxiety, Cognitive Behavioral Therapy (CBT), leaves a large proportion of treated youths within the clinically-impaired range at follow-up (Compton, March, Brent, Albano, Weersing, & Curry, 2004). Depending on cognitive development, some youths may have difficulties with skills such as abstract reasoning and identifying and challenging maladaptive thoughts, which might contraindicate the use of CBT with such children and adolescents (Kingery et al., 2006; Weisz & Weersing, 1999). As discussed previously, adult anxiety researchers have developed novel cognitive bias modification (CBM) interventions that focus on retraining individuals' attention away from negative stimuli or modifying negative interpretations of ambiguous scenarios to be more neutral or positive, with subsequent significant reduction of anxiety symptoms (e.g., Beard & Amir, 2008; Amir et al., 2010). There has also been a call for the downward extension of adult cognitive bias modification studies to youth samples for the

specific purpose of future youth treatment development (e.g., Bar-Haim, 2010; March, 2011). To date, approximately a dozen published CBM studies have been conducted with youths, only half of these in youths with elevated levels of anxiety, and only two conducted in clinically anxious samples (one conducted by the author of the current study, Rozenman et al., 2011; Eldar et al., 2012). As reviewed above, symptom reduction results are promising, but the mechanisms underlying this change are not known. Clarifying divergent findings in the youth IP literature may allow for modifying CBM to be more developmentally appropriate for internalizing youths. Furthermore, clarifying relationships between attention, interpretation, and anxiety symptoms may inform and help confirm or modify our empirical knowledge base of youth IP theory.

AIMS AND HYPOTHESES

Aim 1: To test a prediction of the information processing model of anxiety youth suggesting that interpretation bias statistically mediates the association between attention bias and anxiety severity. Two separate statistical mediation were planned where the relationship between performance-based attention bias towards threat and youth anxiety was proposed to be mediated by (1) negative interpretations endorsed and (2) benign interpretations endorsed. Based on the existing adult IP literature and theoretical models of youth IP, it was hypothesized that the relationship between performance-based attention bias towards threat and youth anxiety would be mediated by negative interpretations endorsed (i.e., negative interpretation bias).

Aim 2: Examine the components of interpretation (i.e., threat valence judgments and speed of responding) using a novel performance-based task of interpretation bias. These exploratory analyses were planned to examine whether endorsement of emotionally-valenced stimuli (benign or negative) and response latency would be associated with one another, as well as whether these aspects of interpretation would be associated with attention biases and anxiety symptoms.

Aim 3: Explore the potential impact of depressive symptoms, in this clinically anxious sample, on these performance-based tasks of attention and interpretation. Exploratory analyses were planned to examine whether greater selective attention towards threatening stimuli and/or more frequent endorsement of negative interpretations of ambiguous sentences would predict youth depressive symptoms. The effect of depression as a moderator of the relationships between cognitive processes, anxiety, and negative self-statements was also examined.

METHODS

Recruitment

Youths were recruited by three means. First, youths seeking services for internalizing problems were offered study participation in the current project as a means of determining eligibility for free treatment studies conducted by this author and Drs. Weersing and Amir (23%); many families reported finding our research clinic's information on the internet, with some referred from other university-based research laboratories in San Diego, such as the SDSU Center for Understanding and Treating Anxiety. Second, a substantial portion of the sample (50%) consisted of families responding to paid advertisements in family magazines, online streaming radio, and newspaper publications. Third, free community recruitment involved advertising on free online websites, posting flyers in public locations (e.g., parks, libraries, laundromats, YMCAs, college campuses, grocery stores, coffee shops, restaurants) throughout San Diego county, recruiting parents of children in the intended age range from the SDSU Psychology Department Research Participation Subject Pool, and receiving approval from San Diego County to recruit from their Community Research Foundation community clinics and centers (27%). Relationships were also developed with and presentations made at other referral sources, including community mental health clinics (i.e., East County Community Clinics, San Diego Youth Services), elementary schools, and a children's hospital outpatient psychiatry clinic. Flyers, advertisements, and presentations referred to free assessment and the potential for free treatment for youths who were "shy, nervous, scared, or sad."

Participants

Inclusion Criteria. Eligible for inclusion were those youths who (a) met for a current primary diagnosis of Separation Anxiety, Social Phobia, or Generalized Anxiety Disorders at assessment, (b) were aged 8 to 17, inclusive, at time of intake, (c) spoke fluent English, (d) were able to read at age level, and (e) lived with a legal guardian who was able to provide consent for study participation.

Exclusion Criteria. Youths were excluded if they: (a) did not meet DSM-IV-TR diagnoses for primary Separation Anxiety, Social Phobia, or Generalized Anxiety Disorder and/or received a diagnosis for some other condition that required immediate intervention (i.e., Attention Deficit Hyperactivity Disorder, Obsessive Compulsive Disorder, Bipolar Disorder, psychosis, Post-Traumatic Stress Disorder, substance dependence) (n=18), (c) had current cognitive or reading problems that might impact ability to complete performance-based tasks (n=8), (d) had experienced recent physical or sexual maltreatment (n=0), (e) suffered from serious or unstable physical illness that might impact ability to complete performance-based tasks, (f) had a change in medication type or dose during six weeks prior to intake (n=0), (g) had received (or were receiving) evidence-based intervention for internalizing problems (n=0), and (h) had a significant change in other psychosocial treatment during twelve weeks prior to intake (n=0). See Figure 2 for additional information about youth recruitment and inclusion/exclusion.

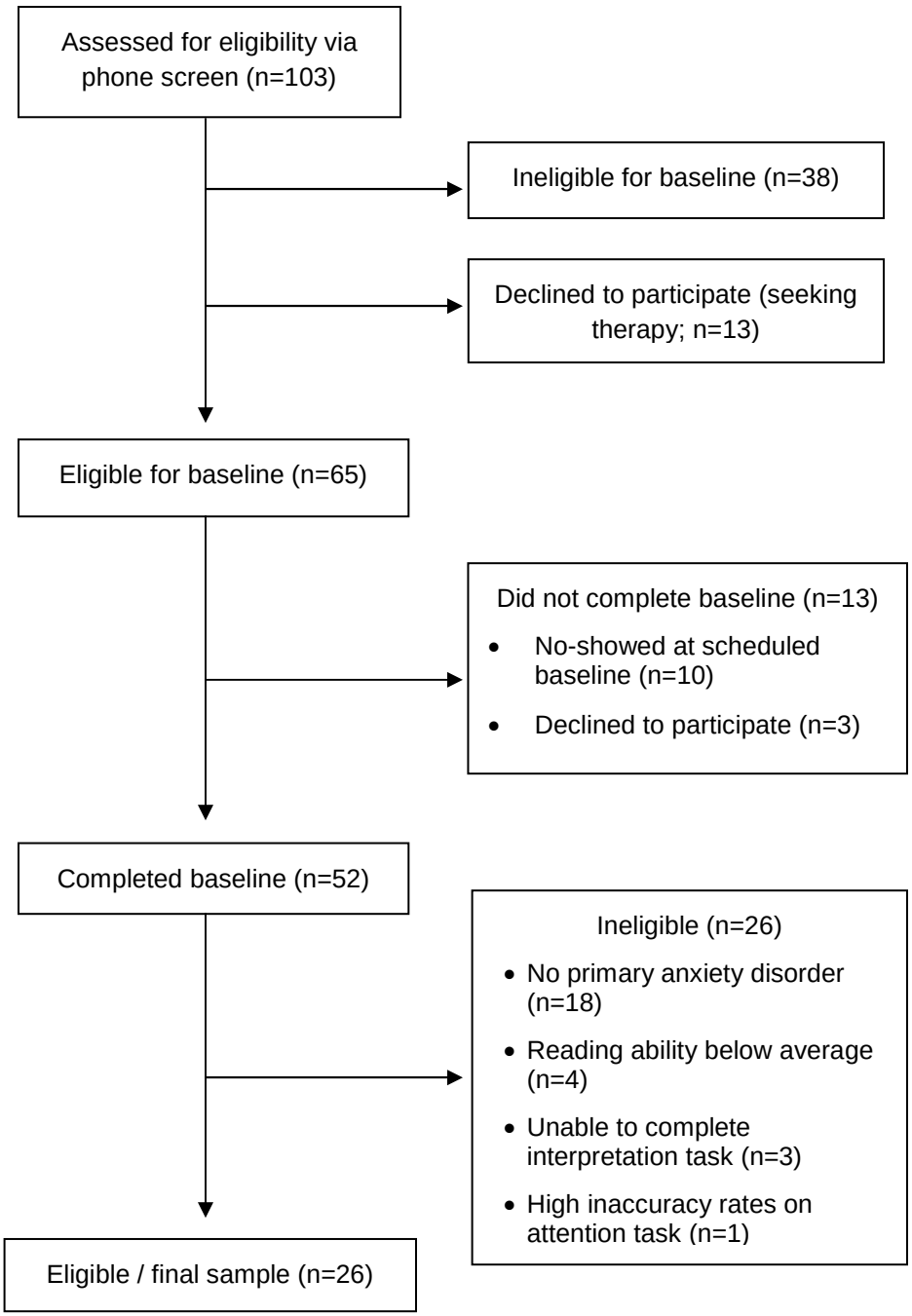

Figure 2. Study recruitment flowchart

Final sample. Fifty-two youths were assessed for the current project. Thirty-four youths met for diagnostic inclusion; however, four of these youths scored in the Extremely Low or Low Average range on the reading test and an additional four youths scored in the average range on the reading test but were unable to complete performance-based tasks with adequate accuracy rates. Therefore, the final sample consisted of 26 clinically anxious youths who successfully completed the full diagnostic interview and all performance-based tasks and self-report questionnaires. See Figure 2 for additional recruitment and study inclusion information.

Youths in the final sample were ages 9 to 17 (M=12.65, SD=2.81) and 39% male. Forty-two percent of the sample consisted of ethnic minorities, with 15% Hispanic, 8% Asian/Pacific Islander, and 19% identifying with more than one racial/ethnic category. All youths met for a primary DSM-IV-TR anxiety disorder, including Generalized Anxiety Disorder (n=14), Social Phobia (n=11), and Separation Anxiety Disorder (n=1). More than half of the sample (58%) met for a second anxiety disorder. In addition, a high proportion of youths (58%) met for clinically significant levels of depressive symptoms or a secondary depressive disorder. All youths in the final sample demonstrated reading abilities within the average range for their age and grade on a well-established word reading test (WRAT-4, see Measures below), with a mean standard score of 103 (SD=14.34; standard scores have a mean of 100 and standard deviation of 15). Table 1 provides additional demographic and clinical characteristics of the final sample.

Table 1. Characteristics of Final Sample (N=26)

Demographics	Mean (SD)	Range
Age	12.65 (2.81)	9 - 17
Ethnic Minority (%)	42%	
Gender (% male)	39%	
Reading standard score	103 (14.34)	89 - 129
Psychopathology		
Primary Generalized Anxiety Disorder (n)	14	
Primary Social Phobia (n)	11	
Primary Separation Anxiety (n)	1	
Secondary Anxiety Disorder (%)	58%	
Secondary Depressive Disorder (%)	19%	
Elevated depressive symptoms (%)	58%	
PARS[1]	22.08 (4.37)	9 - 12
CDRS-R[2]	30.23 (7.39)	17 - 46
Cognitive processing measures		
Attention bias threat index	-5.04 (116.53)	-270.10 – 194.96
Attention bias happy index	-23.21 (123.92)	-325.25 – 144.12
Negative interpretations (%)	58%	
Negative interpretation reaction time index[3]	-48.98 (225.47)	-617.46 – 429.75
Benign interpretations (%)	63%	
Benign interpretation reaction time index[3]	129.30 (227.22)	-917.79 – 306.30

Notes:

[1]PARS scores range from 0 to 30. Scores above 13 are considered to reflect clinically significant levels of anxiety.

[2]CDRS-R scores range from 17 to 113. T-scores of 55 are considered to reflect elevated levels of depressive symptoms.

[3]Interpretation reaction time indices were calculated by subtracting reaction times for rejecting threat from endorsing threat (for threat index) and rejecting benign from endorsing benign. Larger positive scores indicate more bias away from threat and towards benign, respectively.

Procedure

All recruitment and study procedures were approved by San Diego State University and University of California, San Diego Committees for Protection of Human Subjects, and participation in the study was voluntary.

Screening and Consent. Families answering advertisements, calling for services at the SDSU Child and Adolescent Anxiety and Mood Program, or referred by community providers were phone screened for the current study to determine initial inclusion / exclusion and describe the current study purpose and procedures. Over 100 youths were phone screened, with 65 youths eligible for the study assessment (see Figure 2 for recruitment and inclusion information). Thirteen parents declined study participation during the phone screen because they were interested in immediate referrals for cognitive-behavioral intervention. Youths invited to participate in this study completed assent, and parents completed consent, prior to the assessment.

Assessment procedures. Data for this study was collected in a single assessment visit. Youths and parents completed a diagnostic interview and a comprehensive self-report battery (see Measures). Youths also completed a reading test and performance-based assessments of attention and interpretation. Families were paid $25 to thank them for their time and participation; this payment was designed to be small enough to be non-coercive but large enough to reasonably thank youths and their parents for their time, travel, and cooperation. Eligible youths were also offered free computerized treatment for anxiety as part of another study.

Regular clinical supervision meetings were held to triage cases for inclusion. To ensure reliability, all interviews were audio-taped and quality assurance regularly

conducted. Approximately 15% of interviews were rated for reliability, with 100% agreement for all diagnoses and high inter-rater reliability for clinician-rated dimensional symptom measures (r=.83 for anxiety; r=.86 for depression).

Performance-based assessment procedures. Study staff sat in the room with youths in order to ensure that youths completed tasks as directed. Youths were instructed to not speak with staff during the duration of the tasks. If youths did speak with staff during tasks or appeared to stop working on the task, staff responded to youths with a stock prompt ("Please keep working on the computer game; we can talk when you're done.")

Performance-based assessment of attention bias. The attention dot probe task was developed by MacLeod and colleagues (MacLeod, Mathews, & Tata, 1986) and has been modified for use in youth anxiety studies as a measure of performance-based attention (for review, see Bar-Haim et al., 2007). The faces used in the task were selected from a standardized set of emotional expressions (Matsumoto & Ekman, 1989) that have been used in many investigations of performance-based attention (Bar-Haim, 2007). The set includes eight individuals (four men, four women) displaying threatening (i.e., disgust), happy, and neutral expressions.

During the task, research staff read instructions to youths as they followed along with the same instructions on a computer screen. Youths were presented with 256 trials of paired faces. Each trial begins with a fixation cross ("+") presented in the center of the monitor for 500 milliseconds (ms), immediately followed by two faces of the same individual on the top and bottom portions of the screen, with each pair displaying one of two combinations of emotions (i.e., neutral on top and threat on bottom, threat on top and

neutral on bottom, neutral on top and happy on bottom, happy on top and neutral on bottom, or neutral on both top and bottom). Faces were centered horizontally, and positioned 3.0 centimeters from the top of the screen and separated by 1.5 centimeters between the bottom of the top image and top of the bottom image. After presentation of the faces for 500 ms, a probe (either letter E or F) appeared in the location of one of the two faces. Youths were instructed to attend to the location of a probe (letter E or F) and indicate its spatial orientation (top or bottom) on the screen by clicking left or right mouse keys. Probes appeared after facial stimuli presentation. Facial stimuli (disgust, happy and neutral faces) occured in block-randomized combinations for each youth, for 256 total trials. The probe remained on the screen until the youth responded to that trial, after which the next trial began. In the task, for trials in which an emotional face (i.e., threat or happy), was paired with a neutral face, the probe appeared in the same location as the emotional face on 50% of trials. The program monitored accuracy in identifying the probe location, as well as reaction time in response to each trial.

During instructions, youths were not directed to attend specifically to the faces, and told only to attend and respond to the probes as quickly and accurately as possible. One trial of the task is depicted in Figure 3. On average, youths completed the task in approximately 15 minutes.

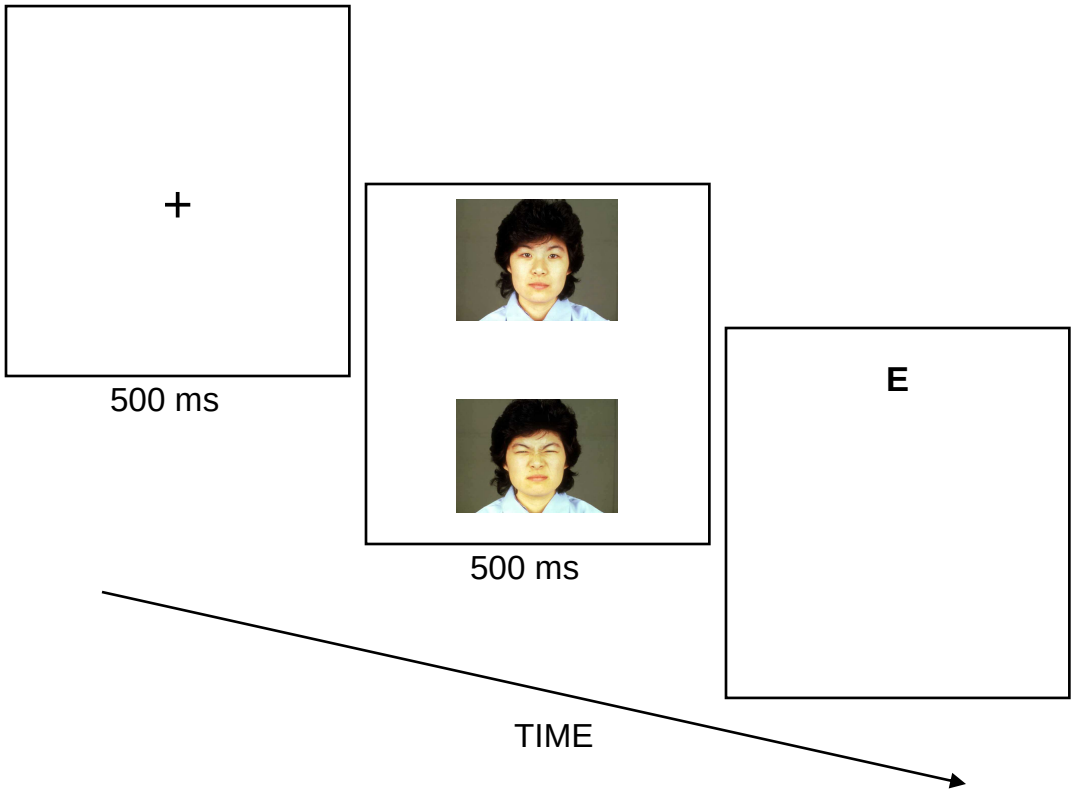

Figure 3. Example of single trial in performance-based attention assessment

Performance-based assessment of interpretation bias. The performance-based interpretation assessment was modified from the adult paradigm developed by Beard and Amir (2008) as described in the Methods section. In the performance-based interpretation task, research staff read instructions to the youth as they followed along with the same instructions on the computer screen. Youths were instructed to watch the screen as a word appears for 500 ms in the center of the screen, with a sentence following the word. Youths were prompted to indicate whether they believed the word and sentence were related by pressing specific keys on the keypad (1 for yes, 3 for no). Word-sentence pairs included a neutral (e.g., “cat”) or threatening/negative (e.g., “burglar”) word that was presented immediately before the corresponding ambiguous sentence (e.g., “You hear a noise outside at night”) for 80 trials. Prior to completing the actual task, youths completed a practice version of the performance-based interpretation assessment, with 20 word-sentence pairs unrelated to the constructs measured in the actual task (i.e., all words during practice were neutral and sentences unambiguous), in order to become familiar with the instructions and task. The interpretation task and practice task took youths approximately 15 minutes to complete. One trial of the task is depicted in Figure 4.

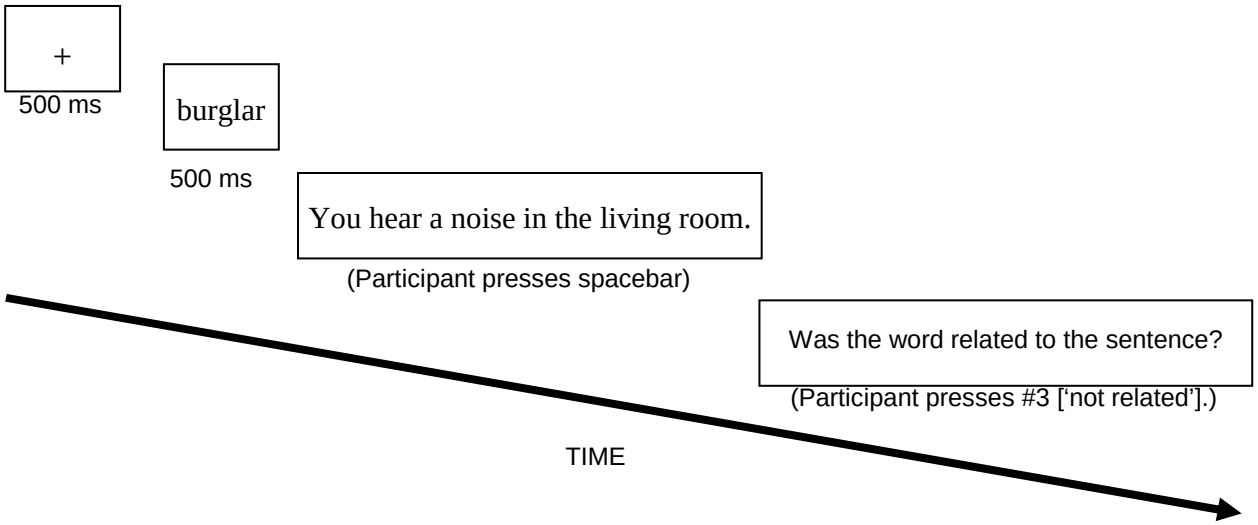

Figure 4. Example of single trial in performance-based interpretation assessment

Measures

Demographic information. The General Information Sheet was developed by the author and ChAAMP program and includes age, ethnicity, gender, school placement, parent socioeconomic information, and household composition.

Youth symptom and diagnostic information. The Schedule for Affective Disorders and Schizophrenia for School-Age Children – Present Version (K-SADS; Kaufman, Birmaher, Brent, & Rao, 1997) was used to assess for diagnosis of anxiety, as well as screen for other DSM-IV-TR Axis I Disorders. This is a widely used diagnostic interview with well-established psychometric properties. As described above, quality assurance was conducted on 15% of K-SADS interviews, with 100% agreement for all diagnoses.

The Pediatric Anxiety Rating Scale (PARS; RUPP, 2002) is an interviewer-rated dimensional measure of anxiety comprised of a 50-item symptom checklist and seven global severity/impairment items summed for a continuous total of 0-35. The PARS has high inter-rater reliability, adequate internal consistency, and fair test-retest reliability. There is support for convergent and divergent validity, and sensitivity to treatment effects in clinical trials (e.g., Walkup et al., 2008). The PARS was the primary anxiety outcome measure in this study. Quality assurance conducted on 15% of interviews for this study demonstrated high inter-rater reliability for the PARS (r=.83). In this sample, Cronbach's alpha for the PARS clinician ratings of the seven severity items was .93.

The Children's Depression Rating Scale – Revised (CDRS-R; Poznanski & Mokros, 1996) is an interviewer-rated dimensional measure of depression that integrates youth and parent report to assess the presence and severity of depression in youths. The CDRS-R is composed of 17 items tapping the major features of depression; scores of 40

and above are considered reflective of a depression diagnosis. The CDRS-R has good inter-rater reliability, internal consistency, convergent validity with other measures of depression in youth, and is sensitive to treatment effects. The CDRS-R was the primary measure of significant depressive symptom co-occurrence. In addition, a t-score cutoff of 55 or greater is used descriptively to characterize elevated levels of youth depression in this sample. Quality assurance conducted on 15% of assessments demonstrated high inter-rater reliability for the CDRS-R (r=.86). In this sample, Cronbach's alpha for the 17 CDRS-R clinician-rated items was .89.

Additional youth symptom outcome measures. The *Screen for Child Anxiety Related Emotional Disorders – Child and Parent Versions* (SCARED; Birmaher, Brent, Chiappetta, Bridge, Monga, & Baugher, 1999) is a 41-item measure of anxiety symptoms with youth (SCARED-C) and parent (SCARED-P) versions. The SCARED is designed to screen for presence of anxiety symptoms in children and adolescents. The SCARED has been validated in diverse clinical and community samples, with good internal consistency and sensitivity to treatment effects. The SCARED was included as a secondary measure of anxiety symptoms because it is widely utilized to screen for anxiety symptoms in community and clinical settings. In this sample, Cronbach's alpha was .76 for the SCARED-P and .81 for the SCARED-C.

The Mood and Feelings Questionnaire (MFQ; Wood, Kroll, Moore, & Harrington, 1995) is a 34-item self- (MFQ-C) and parent-report (MFQ-P) inventory of depressive symptomatology in children and adolescents, with a cutoff score of 25 to indicate clinically significant depressive symptoms. As with the SCARED, the MFQ has good psychometric properties and sensitivity to treatment effects, and is widely used as a

depression screener in community and clinical settings. In this sample, Cronbach's alpha was .71 for the MFQ-P and .84 for the MFQ-C.

Cognitive processing measures. The faces dot probe task was used as a measure of *performance-based attention assessment*. The faces dot probe is a computerized task that assesses whether individuals exhibit biases in their attention to threatening versus neutral information in the form of face pictorials. The task is a modification of that developed by MacLeod and colleagues (MacLeod et al., 1986), and has been used in many adult and youth studies assessing attentional biases across the internalizing spectrum (see Procedure section above for task description). The task provides reaction time indices utilizing the Mathews and MacLeod formula (see Table 2 in Data Analysis Plan) for youth speed of responding on a) disgust versus neutral faces, and b) happy versus neutral faces.

To examine performance-based interpretation bias, a computerized task was used that assesses whether youths exhibit biases in their interpretation of ambiguous scenarios. This task was modified from a task developed by Beard and Amir (2008). This author and her mentors modified the task's stimuli for use with youths by comprehensively reviewing the youth anxiety and depression literatures (child internalizing treatment manuals, self-reports, clinician-rated assessments, and clinical experiences with youths) for developmentally-relevant items. Although this is a novel measure of performance-based interpretation bias in youths, the stimuli and program have been validated for use with anxious youths, with sensitivity to treatment effects (Rozenman, Bettis, Goldberg, Amir, & Weersing, 2011). The task provides a measure of a) percent negative interpretations endorsed from all possible threat word stimuli and b) percent benign

interpretations endorsed from all possible benign word stimuli. The task also measures youth speed of responding, with four types of reaction times, as taken from Beard and Amir (2008; 2009): a) endorsement of negative interpretations, b) rejection of negative interpretations, c) endorsement of benign interpretations, and d) rejection of benign interpretations. Negative and positive bias indices were also calculated for reaction time data: negative bias (mean reaction times for rejecting negative minus endorsing negative), and benign bias (mean reaction times for endorsing benign minus rejecting benign). Larger bias scores indicate more bias towards negative and benign interpretations, respectively.

Self-reports of negative cognition. The Automatic Thoughts Questionnaire – Children's Revised Version (ATQ-R with ATQ-negative and ATQ-positive subscales; Kendall, Stark, & Adam, 1990) is a 40-item self-report inventory with negative (30 items) and positive (10 items) subscales, originally developed to assess negative thinking associated with youth depression. Youths respond to items by selecting how often they have experienced specific negative or positive thoughts in the past week. A variety of studies have supported the reliability and validity of the ATQ-C in clinical and non-clinical community samples of youths. The ATQ-C has also been utilized as a measure of interpretation bias in cross-sectional and longitudinal studies of information processing in youths (e.g., Possel, Seemann, Ahrens, & Hautzinger, 2006). It was used in this dissertation as a comparison to performance-based assessment of cognitive processing, particularly the performance-based interpretation task.

The Children's Automatic Thoughts Scale (CATS; Schniering & Rapee, 2002) is a 40-item self-report inventory of negative self-statements, originally developed to assess

negative thinking related to threat and hostility in youth anxiety. Youths respond to items by selecting how often they have thought specific threatening or hostile statements in the past week. Although the CATS has not been specifically utilized as an interpretation measure, it was developed to target negative cognition for anxiety, and therefore is used in this dissertation as a supplement to the ATQ-R, which was originally developed to assess negative thinking in youth depression.

Youth reading ability. The Wide Range Achievement Test – Fourth Edition – Reading Subtest (WRAT-4; Wilkinson & Robertson, 2006) is a well-established reading test and contains standard scores for youths according to age and grade. The WRAT-Reading subtest was administered to youths to ensure that they are able to read at age level, as the ability to read is critical to completing the performance-based interpretation task.

Data analysis plan

General data screening and preparation. First, data were screened to check for outliers and missing data patterns, using histograms and scatter plots. Age was explicitly examined as a potential covariate, especially in relation to depressive symptoms and performance on the interpretation task. Age was significantly correlated with depressive symptoms; this was expected, as depression rates are higher in adolescence. Examination of depressive symptoms was explicitly measured as part of Aim 3. Age was not significantly related to performance on attention or interpretation tasks using mean reaction times on attention and interpretation tasks, or to percentage of interpretations endorsed on the interpretation task. In examining all attention trials for all youths after, it was found that older youths (ages 13 to 17) were significantly slower (M=917.64, SD=428.51) in their

reaction times than younger youths (ages 9 to 12; M=881.52, SD=477.67), F(1,25)=9.44, *p*=.002). However, inclusion of age as a covariate in subsequent aims did not allow for improved prediction of outcomes; therefore, age is not included as a covariate in the final results below.

Performance-based data. Prior to data analyses, data were screened and cleaned to eliminate errors as is typical practice in both adult and youth cognitive processing studies (e.g., Beard & Amir, 2008; Rozenman, Weersing et al., 2011; Taghavi et al., 1999). Procedures for attention and interpretation are described below.

Attention. For the attention task, response latencies were identified for inaccurate trials (where youth presses wrong button for probe correspondence). Youth studies have demonstrated inaccuracy rates of up to 25% on performance-based cognitive tasks (e.g., Roy et al., 2008). Based on the data required for analyses, specific inaccurate trials were eliminated if a youth responded accurately to 85% of trials. One youth assessed for the study met all other inclusion criteria but responded with an inaccuracy rate of 65% on the attention task; for this reason, this participant was excluded from the final sample (see Figure 2). On average, youths in the sample were accurate on 94% of trials. Accuracy rates of included youths ranged from 85% to 100%. The use of a more stringent accuracy threshold (90%) would have resulted in the exclusion of four youths who demonstrated accuracy rates ranging from 85 to 89%. Analyses conducted with and without these youths did not differ; therefore, these four youths were included in the final sample. Overall, 6% of trials were removed for inaccuracy.

In addition, the first five trials were removed for each youth (2% of trials for the entire sample, less than 1% of trials for each youth). These trials were removed after

examination of the data revealed significantly longer response latencies for trials 1 through 5 (M=2784.13, SD=4000.55), as compared to subsequent trials 6 through 256 (M=934.50, SD=722.63; $F(1,25)=506.01$, $p<.001$). These relatively longer response latencies for the first five trials may have been due to youths becoming acclimated to the speed and format of the attention task. Finally, probe detection latencies less than 350 ms and more than 3500ms were excluded from analyses. Latencies less than 350 ms are very fast, suggesting that youths either responded prematurely or were still holding the mouse key or keypad button down from the prior trial. Latencies greater than 3500 ms could be due to a lapse of attention, computer failing to register a button press, or higher-order processing that may be too controlled for inclusion within the performance-based attention task. Across the sample, 2% of trials were removed due to response time latencies that were too fast or too slow.

For each youth, mean attention bias scores were derived from the standard formula developed by Mathews and MacLeod (2005; see Table 2) used across adult, and several youth, studies. This formula calculates bias for each participant by subtracting mean reaction times when the specified negative or happy facial type and probe appear on the same location of the display from the mean reaction time on trials where that face and probe appear on opposite location of the display. Positive values reflect bias towards negative or happy facial stimuli relative to neutral faces, whereas negative values reflect bias away from negative or happy stimuli.

Table 2. Variable descriptions for bias calculation formula

Variable name	Top face	Bottom face	Probe location
NDT	Neutral	Disgust	Top
DNT	Disgust	Neutral	Top
DNB	Disgust	Neutral	Bottom
NDB	Neutral	Disgust	Bottom

Note: Attention bias is calculated by subtracting mean reaction times when the specified negative facial type and probe appear on the same side of the display from the mean reaction time on trials where that face and probe appear on opposite sides of the display. For example, bias for disgust faces (in ms) = [(NDT – DNT) + (DNB – NDB)]/2. Positive values reflect bias towards that negative facial stimuli type relative to neutral faces, whereas negative values reflect bias away from negative stimuli.

Interpretation. For the interpretation task, probe detection latencies less than 200 ms and more than 3500 ms were excluded from analyses (Beard & Amir, 2009). Again, latencies outside of the 200 to 3500 ms range could be due to a lapse of focus on the task, computer failing to register a button press, or higher-order processing that may be too controlled for inclusion within a performance-based interpretation task. Three youths were excluded from the final sample on the basis of this range of probe detection latencies. In the final sample of 26 youths, 5% of interpretation trials were removed due to response time latencies that were too fast or too slow. Individual youths ranged from 92% to 97% of trials in the acceptable range of 200 to 3500 ms. Age was not significantly related to mean reaction times or variability in reaction times on the interpretation task when conducting correlations or when splitting the sample into younger (9 to 12 years) and older (13 to 17 years) age groups.

Mean interpretation bias scores were derived for each youth as the percentage of negative interpretations endorsed out of all negative interpretations possible (from trials when negative stimuli paired with ambiguous sentence) and benign interpretations

endorsed out of all benign interpretations possible (from trials when benign stimuli paired with ambiguous sentence; Beard & Amir, 2009). On average, youths endorsed 58% of negative words as related to ambiguous sentences (SD=15%; range 22% to 91%) and 63% of benign words as related to ambiguous sentences (SD=15%; range 28% to 89%).

Defining other interpretation indices. Youth reaction times on the performance-based interpretation task were also measured to examine the relatedness of negative and benign interpretations to the ambiguous sentences. This resulted in four sets of reaction times: a) endorsement of negative interpretations, b) rejection of negative interpretations, c) endorsement of benign interpretations, and d) rejection of benign interpretations. Negative and positive bias indices were calculated for reaction time data: negative bias = reaction times (reject negative – endorse negative) and benign bias = reaction times (endorse benign – reject benign). Larger scores indicate more bias toward threat and benign interpretations, respectively. The average negative bias index was 48.91 (SD=225.47), while the average benign bias index was -124.13 (SD=277.22).

Analysis of Aims

A variety of statistical methods were used to address primary and exploratory aims of this study. Methods for analysis are described by aim.

Primary Aim 1: Empirically test the information processing model of anxiety in youth, specifically whether interpretation statistically mediates the association between attention and anxiety severity. To conduct an initial examination of whether attention exerts its influence on anxiety through interpretation, negative interpretations endorsed and benign interpretations endorsed were each tested as potential statistical mediators between attention bias scores and anxiety symptom severity (as measured by the PARS)

in two distinct mediation models. Based on the existing adult IP literature, and theoretical models of youth IP, it was hypothesized that the relationship between performance-based attention bias towards threat and youth anxiety severity would be mediated by negative interpretations endorsed. Bias-corrected bootstrapping procedures (Efron & Tibshirani, 1993; Preacher & Hayes, 2008) were used to assess the indirect effect of attention biases on youth anxiety severity through the proposed statistical mediators (negative and benign interpretation biases). Bootstrapping is currently considered the mediation method which is most advantageous because it assesses the indirect effect of the independent variable through the construction of confidence intervals and does not make assumptions about the shape of the sampling distribution of the indirect effect (e.g., Fritz & MacKinnon, 2007; MacKinnon, Lockwood, Hoffman, West, & Sheets; 2002).

Aim 2: Examine the components of interpretation (i.e., threat valence judgments and speed of responding) on a novel performance-based task of interpretation bias. To date, there is little precedence for examining reaction times for performance-based interpretation biases in youths. Based on a prior study of performance-based interpretation bias in anxious adults (Beard & Amir, 2009), mean reaction times for youth response latency were calculated for a) endorsement of negative interpretations, b) rejection of negative interpretations, c) endorsement of benign interpretations, and d) rejection of benign interpretations. Each of these reaction times was correlated with the negative and benign endorsements on the interpretation task, as well as attention biases and anxiety symptoms. These correlations were compared to examine whether endorsement of negative stimuli or response latency might be a more useful predictor of interpretation bias for future tests of the information processing model. Reaction time

indices for negative bias and benign bias were also examined. All variables were also compared to self-reports of negative self-statements, which have been used as interpretation measures in prior youth information processing investigations.

Aim 3: Explore the potential impact of depressive symptoms, in this clinically anxious sample, on these performance-based tasks of attention and interpretation. First, correlations between depressive symptoms, attention, and interpretation were examined. Then, depression was examined as a potential moderator of the relationship between attention and anxiety in one linear regression model, and interpretation and anxiety in a second linear regression model. Finally, one-way ANOVAs were conducted to dichotomously examine whether presence or absence of significant depressive symptoms (CDRS-R t-score of 55 or greater) were related to anxiety or performance-based cognitive processing measures.

RESULTS

Aim 1: Test information processing model

The first goal in this investigation was to test relationships between attention, interpretation, and anxiety severity as proposed in youth IP models. Specifically, negative interpretations were proposed to mediate the relationship between attention bias towards threat and anxiety severity. As planned, bias-corrected bootstrapping was conducted as a test of statistical mediation in order to account for non-normally distributed data and the small sample size. This test provides a bootstrap estimate based on 1000 sampling iterations of each direct and the indirect effect *(ab)*, with 95% confidence intervals for the population of *ab*. Analyses revealed that, while attention did not significantly predict anxiety, the percentage of negative interpretations endorsed significantly and substantially accounted for 46% of variance in anxiety severity scores within this clinical sample of anxious youths (β=19.38, $F(1,25)=20.96$, R^2=.46, p<.001). The 95% confidence intervals of the indirect path (*ab*) overlapped with zero for anxiety severity (lower CI=-.003, upper CI=.032), indicating that the indirect effect of attention on anxiety severity through interpretation was not significant. As hypothesized, anxiety severity was not significantly predicted by percentage of benign interpretations endorsed.

To unpack these results, Pearson correlations were examined for attention, interpretation, anxiety severity (as measured by the PARS) and anxiety symptoms (as measured by parent and child reports on the SCARED). In addition to the traditional threat index of attention, attention bias towards happy was also included in these analyses to explore whether an alternate operationalization of attention might help to explain relationships between attention, interpretation, and anxiety. Percentage of negative

interpretations endorsed was significantly correlated with anxiety severity (r=.68, p<.001) and attention bias towards threat (r=.46, p=.019). However, attention bias towards threat was not associated with the PARS, SCARED-C, or SCARED-P. Attention bias towards happy faces was examined as an alternate attention index and was negatively and significantly correlated with the SCARED-P (r=-.49, p=.01), such that higher parent ratings of youth anxiety symptoms was associated with less bias towards happy faces. Reduced attention bias towards happy also predicted 25% of variance in parent-reported anxiety symptoms for youths (β=-.49, F(1,25)=7.91, R^2=.25, p<.01), but attention bias towards happy faces was not significantly correlated with anxiety severity (PARS) or any interpretation variables. Moreover, no interpretation variables were significantly associated with SCARED scores, and additional exploratory analyses with attention (e.g., is attention bias towards either threat or happy faces mediated by other interpretation indices, depression, or negative self-statements in predicting parent reports of child anxiety?) did not lead to any other significant results on anxiety. The finding that neither attention bias towards threat or happy was significantly associated with the gold-standard measure of anxiety in the field (PARS) was somewhat, but not entirely, surprising, given that attention bias findings in the youth anxiety literature have been inconsistent. Indeed, in this clinically anxious sample, attention bias was quite variable, with some youths showing classic bias towards threat, some showing no bias, and some showing bias *away* from threat. Mean attention bias scores for this sample ranged from -270.10 to 194.96 (M=-.504, SD=116.53) for disgust faces and -325.25 to 144.12 (M=-23.21, SD=123.92) for happy faces.

In a final attempt to understand the attention results in this sample, demographic and clinical covariates were explored. Age and anxiety did not predict attention bias dimensionally or when the sample was split into groups of youths exhibiting bias towards versus away from threat. Additional regressions conducted with depression entered as a covariate or as a dependent variable did not help to explain any additional associations between attention and other variables. See results for Aim 3 below for additional analyses conducted to examine depression in this sample.

Aim 2. Examine components of interpretation

Previous studies of interpretation bias in anxious adults have utilized percentage of negative and benign interpretations endorsed as the most common metric of interpretation bias (e.g., Beard & Amir, 2009). A secondary aim of this study was to probe the components of interpretation to examine which might be the most useful indicators of interpretation bias. As described in the Methods and Data Analysis Plan, interpretation was deconstructed into its components: percentages of negative and benign interpretations endorsed, reaction times for endorsing and rejecting negative interpretations, reaction times for endorsing and rejecting benign interpretations, and negative and benign reaction time indices.

First, correlations between these interpretation variables, attention bias, and anxiety were examined (see Table 3). Of all interpretation variables, percentage of negative interpretations endorsed was most consistently associated with symptoms and self-report indices, with significant associations with attention bias towards threat (r=.46, p=.019) and anxiety severity (r=.68, p<.001). Negative (r=.40, p=.046) and benign (r=-.42, p=.034) interpretation reaction time indices were also significantly correlated with

youth self-report of anxiety symptoms (SCARED-C). Next, associations between interpretation variables and self-reported negative thoughts were examined (CATS; ATQ-R divided into ATQ-negative and ATQ-positive subscales). Percentage of negative interpretations endorsed was significantly correlated with negative (ATQ-negative subscale r=.44, p=.028) and positive (ATQ-positive subscale r=-.43, p=.034) self-statements. Interestingly, the benign bias reaction time index was correlated with the two self-report measures of negative cognition (ATQ-negative subscale r=-.71, p<.001; CATS r=-.55, p=.004). In comparing reaction times for benign interpretation endorsement and rejection separately, only reaction time for rejecting benign interpretations was significantly correlated with negative self-statements (ATQ-negative subscale r=.533, p=.004; CATS r=.450, p=.021), such that slower rejection of benign interpretations was associated with higher levels of self-reported negative cognition.

Table 3. Bivariate Correlations Between Internalizing Symptoms, Self-Reported Cognition, and Performance-Based Attention and Interpretation

	Internalizing measures					
	PARS	SCARED-C	SCARED-P	CDRS-R	MFQ-C	MFQ-P
Internalizing measures						
PARS	---					
SCARED-C	.58**	---				
SCARED-P	.54**	.55**	---			
CDRS-R	.14	.16	-.23	---		
MFQ-C	.40*	.71**	.18	.55**	---	
MFQ-P	.35	.35	.36	.56**	.57**	---
Self-reported cognition						
CATS	.39*	.68***	-.03	.51**	.79***	.21
ATQ-negative	.38	.67***	.03	.51**	.85***	.37
ATQ-positive	-.09	-.22	-.11	-.21	-.39	-.24
Attention						
Threat bias	.18	.15	.25	.08	.15	.23
Benign bias	-.15	-.29	-.50**	.42*	.09	.24
Interpretation						
% negative endorsed	.68***	.31	.30	.26	.33	.44*
% benign endorsed	.16	-.08	.09	-.08	-.23	-.01
Negative index (rt)	.45*	.40*	.31	-.36	.10	-.06
Benign index (rt)	-.17	-.42*	.01	-.20	-.61**	-.20

Note: * Significant at $p<.05$; **Significant at $p<.01$, ***Significant at $p<.001$

Table 3. Bivariate Correlations Between Internalizing Symptoms, Self-Reported Cognition, and Performance-Based Attention and Interpretation, Continued

	Self-reported cognition			**Attention**	
	CATS	ATQ-negative	ATQ-positive	Threat bias	Benign bias
Self-reported cognition					
CATS	---				
ATQ-negative	.91***	---			
ATQ-positive	-.41*	-.47*	---		
Attention					
Threat bias	.12	.23	-.43*	---	
Benign bias	-.03	.08	-.04	.00	---
Interpretation					
% negative endorsed	.34	.44*	-.43*	.46*	-.04
% benign endorsed	-.11	-.10	.03	-.02	.19
Negative index (rt)	.12	.08	-.03	-.18	-.33
Benign index (rt)	-.55**	-.71***	.37	-.16	-.07

	Interpretation			
	% negative endorsed	% benign endorsed	Negative index (rt)	Benign index (rt)
Interpretation				
% negative endorsed	---			
% benign endorsed	.34	---		
Negative index (rt)	.24	.08	---	
Benign index (rt)	-.16	.04	.10	---

Note: * Significant at $p<.05$; **Significant at $p<.01$, ***Significant at $p<.001$

Aim 3. Explore associations with depression.

Next, relationships between indices of attention, interpretation, and self-report of negative cognition were explored as predictors of depression symptoms. Selective attention towards happy faces was significantly and positively associated with clinician-rated depressive symptoms (CDRS-R; r=.42, p=.032), such that increased bias towards happy faces was related to higher clinician ratings of depressive symptoms. This finding was both surprising and unexpected, given the significant *negative* association between attention bias towards happy faces and parent report of youth anxiety ((r=-.49, p=.01; also described above in Aim 1). Percentage of negative interpretations endorsed was positively correlated with parent report of youth depression symptoms (MFQ-P, r=.44, p=.026). Finally, the benign interpretation bias reaction time index was significantly and negatively associated with youth report of depressive symptoms (r=-.61, p=.001). Examining depression as a covariate, moderator, or outcome variable did not lead to additional significant findings.

Depressive symptoms were also examined dichotomously by splitting the sample into youths with (n=15) and without (n=11) elevated depressive symptoms as defined by a t-score greater than 55 on the CDRS-R and/or a total score greater than 25 on MFQ-P or MFQ-C. One-way ANOVAs revealed group differences for youth age ($F(1,25)=8.59$, p=.007), such that, on average, youths with elevated depressive symptoms (M=13.87, SD=2.59) were two years older than youths without elevated depressive symptoms (M=11.04, SD=2.28). In addition, there was a trend towards anxiety severity differences ($F(1,25)=3.58$, p=.071), such that youths with elevated depressive symptoms (M=23.40, SD=2.64) scored approximately three points higher on the PARS than youths without

elevated depressive symptoms (M=20.27, SD=5.64). There were no group differences in attention or interpretation variables. Youth reports of negative self-statements demonstrated larger and more consistent correlations with depressive symptoms in this clinically anxious sample (CATS r=.51, p=.008; ATQ-negative subscale r=.90, p<.001) than the performance-based interpretation task.

DISCUSSION

The goal of this dissertation was to test youth anxiety information processing (IP) theories by examining the relationship between attention, interpretation, and anxiety within a sample of youths with anxiety disorders. While IP models have been widely tested and empirically supported in internalizing adults, the youth literature is at a far earlier stage of development. In youths, the majority of investigations to date have focused on higher order cognitive processing (e.g., how youths generate and select responses to perceived threat), and the majority of empirical support has been provided via self-report assessment and observation of youth behavior. Studies using state-of-the-art methods and measurement (i.e., performance-based tasks) to assess the early components of how information is encoded and interpreted have demonstrated mixed findings. Attempts to sort through discrepancies in whether all youths demonstrate bias towards threat, whether there is specificity in bias effects depending on symptom presentation or assessment stimuli and methods, and how to appropriately benchmark child IP findings against the adult literature have resulted in controversy in the field. In addition, there have been questions raised about whether assessment of comorbidity may help to explain the inconsistencies in the youth attention literature, though few have attempted to explicitly test depressive symptoms as a moderator or predictor of attention bias in anxious youths. Furthermore, very few investigations with youths to date have assessed interpretation bias via performance-based means, and the little work done in this area has not examined specific components of interpretation related to response latency.

Review papers have called for additional studies to answer these questions, both to disentangle the youth attention bias findings and to include measures of other

information processing variables, such as interpretation (Beard, 2011; Daleiden & Vasey, 1997; March, 2011). This is especially relevant as the field establishes the efficacy of cognitive bias modification (CBM) in anxious adults and has quickly moved to begin testing CBM in anxious youths. CBM protocols modify how stimuli are presented within performance-based attention and interpretation tasks in order to train individuals to attend to neutral, rather than threatening, stimuli and to interpret ambiguous information as benign or positive, rather than negative. The specifics of how to manipulate cognitive processing are more established for CBM in anxious adults, as the literature has more clearly supported the directionality of biases and how presence of comorbid conditions, such as depression, alters cognitive processing. In contrast, inconsistencies in the few youth attention bias and performance-based interpretation bias studies raise questions about whether the field is sufficiently informed by empirical findings to determine how CBM might best be personalized to treat youth anxiety.

In this context, the broad aim of this dissertation was to assess whether the pattern of information processing, as proposed to occur in anxious youths, would hold in this clinically anxious sample when using up-to-date performance-based measures tapping early cognitive processing. Specific aims included 1) testing whether the relationship between attention and anxiety is statistically mediated by interpretation, 2) examining the components of information processing in youths, and 3) assessing whether comorbid depressive symptoms might account for variance in relationships between attention, interpretation, and anxiety in this sample of clinically anxious youths. An interesting pattern of results emerged, that both supports the IP literature for anxious youths and adds to current controversies in the field.

Links between attention, interpretation, and anxiety

As predicted *a priori*, in this sample attention bias towards threat was significantly associated with percent of negative interpretations endorsed on the performance-based interpretation task. Percent of negative interpretations endorsed was significantly and substantially associated with anxiety, predicting 46% of the variance in clinician anxiety severity ratings. This pattern of results supports a relationship between the first two links in classic youth anxiety IP models. Despite these two significant associations, attention bias towards threat was not significantly associated with anxiety severity or symptoms. Examination of the attention data found notable variability in youth attention bias, with some youths attending towards threat, some attending away from threat or towards neutral, and some exhibiting no differences in attention for threat versus neutral stimuli. This variability in the attention data was not explained by age or comorbid depression.

Although the classic attention threat index was not associated with youth anxiety severity in this sample, interestingly, bias towards happy faces was negatively correlated with parent-report of youth anxiety symptoms and, as discussed later, positively correlated with clinician ratings of youth depression symptoms. This first association is consistent with current hypotheses in the field and some findings in the attention literature that bias away from happy is related to more anxiety symptoms. While three investigations have found that youths with more anxiety symptoms demonstrate greater biases towards happy stimuli (or emotional stimuli in general, regardless of valence; Reinholds-Dunne, Mogg, Esbjorn, & Bradley, in press; Waters, Henry et al., 2010; Waters et al., 2008), other findings from the youth literature have either found a negative

association between bias for happy and anxiety symptoms or have not supported a link between bias towards happy and anxiety, when comparing anxious youths to non-anxious comparison groups (Pine et al., 2005; Roy et al., 2008; Waters, Kokkoris et al., 2010). In the adult literature, the majority of work suggests that anxious adults, as compared to non-disordered controls, do not demonstrate a bias towards happy, and that bias towards happy is associated with lower levels of anxiety symptoms in community samples (e.g., Mogg & Bradley, 2005). In this sample, conducting additional analyses with attention bias towards happy as a predictor or moderator did not result in any additional findings or clarification of the association between bias towards happy and anxiety symptoms.

In sum, Aim 1 of this dissertation was partially supported. Despite a relationship between attention towards threat and percent negative interpretations endorsed, and a link between negative interpretation and anxiety severity, attention bias towards threat was not significantly associated with anxiety severity in this clinically anxious sample. This raises questions about how to conceptualize the role of attention in clinically anxious youths, especially in the context of the mixed findings in the existing youth literature. Age was not related to variability in attention bias; neither was presence of depressive symptoms. An ongoing question in the field is whether there are subgroups of anxious youths defined by differences in IP, such that some youths demonstrate bias towards threat while others do not. Presence of more severe attention bias and inability to disengage from threatening stimuli has been found to predict poorer treatment response to CBT in one investigation (Legerstee et al., 2009), but better treatment response in another (Waters, Mogg, & Bradley, 2012). More recently, a study of attention bias modification in anxious youths set exclusion criteria for youths who did not demonstrate a certain level

of bias towards threat (Eldar et al., 2012). However, in this dissertation study, there were no significant differences when dividing clinically anxious youths into groups demonstrating bias towards versus away from threat, or towards versus away from happy. Future work might clarify whether biases for emotional stimuli informs which youths should be selectively targeted as candidates for CBM. These findings – that attention bias for threat was significantly associated with performance-based interpretation, and that attention bias for happy stimuli was negatively associated with parent report of youth anxiety symptoms – contribute to the small extant youth IP literature and suggest promise for continuing to study these constructs together in anxious youths.

There may also be study-specific reasons the original attention hypothesis, that the relationship between attention bias towards threat and anxiety severity would be mediated by percent of negative interpretations endorsed, was not statistically supported. First, stimuli during the attention task were presented at 500 ms, which, while common in adult attention studies, may have been too fast for youths to encode. Some investigations with youths have presented stimuli for longer latencies in attempts to translate these tasks to youths, who may not have similar attentional capacities as adults (e.g., 1500 ms; Dalgleish et al., 2003). While this strategy may be intuitively appealing, findings from the adult internalizing disorders literature indicate that presenting information for longer latencies than 500 ms may tap attentional processes that are potentially more relevant for depression than anxiety (Mathews & MacLeod, 2005; Mogg & Bradley, 2005), which may fundamentally change the attentional processes targeted. Again, youth studies comparing attention at 500 and 1250 ms have produced mixed findings, and the literature has yet to address whether attention bias variability measured in youths is similar enough

to variability measured in adults in order to presume the same time criterion for assessment. Second, the facial stimuli used in the attention task may have been too specific to certain areas of anxiety (i.e., social concerns) than if more generalized (e.g., including angry and sad faces, non-face pictures, or words) were used. However, a study of attention bias modification in a sample of clinically anxious youths was successful in treating a variety of youth anxiety disorders by training youths away from disgust facial stimuli (Rozenman et al., 2011).

Deconstructing interpretation

While support for the overall IP hypotheses in Aim 1 was mixed, specific findings on the links between interpretation and anxiety were very promising. Percent of negative interpretations endorsed predicted 46% of variance in anxiety severity and was also significantly associated with attention bias towards threat and youth self-reports of anxiety and negative cognition. Moreover, as predicted, percentage of benign interpretations endorsed was not significantly associated with anxiety. Aim 2 involved an exploratory examination of the components of interpretation to compare indices of performance-based interpretation in this clinical sample of anxious youths. Percentage of negative interpretations endorsed was more consistently associated with attention, symptoms, and negative self-statements than reaction times for threat stimuli in the interpretation task. However, slower rejection of benign interpretations was associated with higher levels of youth-reported anxiety symptoms, as well as both measures of negative self-statements. This relationship between the benign interpretation reaction time index and anxiety symptoms was not moderated by age or depressive symptoms.

Finally, the benign interpretation bias reaction time index was not more strongly associated with anxiety severity than the percentage of negative interpretations endorsed.

Overall, the performance-based interpretation findings in this study were very encouraging, as this dissertation was the first investigation of performance-based interpretation in youths. Interpretation was operationalized in alternate ways, including percentage of negative and benign interpretations endorsed and youth response latencies for endorsing and rejecting negative and benign interpretations. These findings suggest that performance-based interpretation may provide more useful information than self-reports in understanding youth anxiety, as percentage of negative interpretations endorsed accounted for variability in anxiety severity and demonstrated an association with attention bias towards threat, while negative self-statement questionnaires did not. Moreover, interpretation modification has been demonstrated to decrease both anxiety symptoms and attention bias towards threat in adults (Amir et al., 2010). As this was the first test of performance-based interpretation in a clinical sample of anxious youths, it is yet early to speculate too broadly about the empirical support for interpretation in the youth anxiety IP model. However, there may be reason to differentiate adult and youth IP models if interpretation, and not attention, biases empirically play a more significant role for youths in future investigations. Specifically, it may be possible that basic cognitive processes are more malleable as a function of development and shorter timeframe of disordered thinking and experience in youths, as compared to adults. If the substantial and significant association between performance-based interpretation and anxiety replicated, interpretation may be identified as the common link for anxiety and attention bias towards threat in youths, with implications for youth anxiety IP theory. A stronger

link for interpretation and anxiety than attention and anxiety in youths may help to explain the inconsistent attention findings in the child literature to date. In turn, this may result in modification of IP theory, such that interpretation, and not attention, would be implicated in the development of anxiety and, as attention bias developed through selection of negative attributions to ambiguity, attention might then interact with interpretation iteratively to maintain anxiety. Interpretation might subsequently be considered a more relevant construct for assessment and more appropriate target for intervention. Of course, the field is far from making such claims, but the present study has provided compelling evidence for a strong and significant link between performance-based interpretation and anxiety severity, with percent of negative interpretations endorsed as the only variable to significantly correlate with attention bias towards threat. Future investigations of performance-based interpretation bias might seek answers to these more complicated questions.

Depression as an outcome and moderator

In Aim 3, the focus of this study was expanded to comorbid depressive symptoms as both a potential outcome of information processing and a potential moderator of relationships between IP stages and anxiety symptoms. The primary depression measure (CDRS-R) in this study was not statistically associated with any predictors when analyzed as a continuous or dichotomous variable, or with anxiety severity when analyzed continuously. There was substantial variability in depressive symptoms in this clinically anxious sample, suggesting that restriction in range was not a plausible explanation for the lack of a depression finding. In studies of information processing in adults, depression has been found to impact specificity of cognitive biases.

Moreover, presence of depression in childhood and adolescence predicts worse outcomes for anxious youths (Last, Cohen, & Franco, 1997).

In this sample, both attention bias towards happy faces and rejection of benign interpretations were correlated with depressive symptoms. As discussed previously, the theoretical basis for a relationship between attention for happy faces and elevated depression symptoms is less clear or consistent with findings from youth and adult IP literatures. Findings from the youth and adult IP literatures have not found associations between depression and attention bias for happy faces (Dalgleish et al., 2003; Mogg & Bradley, 2005; Neshat-Doost et al., 2000), however these studies typically compare primarily depressed individuals to non-depressed controls, and have not focused on level of depressive symptoms within primarily anxious individuals. Conversely, the relationship between higher levels of youth-reported depressive symptoms and slower rejection of benign interpretations is broadly consistent with findings in the adult depression literature. Adult IP studies indicate that depressed individuals demonstrate biases toward and have difficulty disengaging from positive stimuli when those stimuli are self-referent and presented at longer latencies (e.g., Mogg & Bradley, 2005). Although the threat and benign word stimuli in this study were only presented for 500 ms, all sentences were written to be self-referent for youths (e.g., “You hear a noise outside at night”; “Your parent is not home yet”) and sentences remained on the screen until youths indicated with a key press that they had read the statement, which may have provided time for more elaborative processing. If this finding is replicated in the future, there may be implications for how youth IP models conceptualize the impact of elevated depressive symptoms in anxious youths’ interpretations. These exploratory analyses and

results may serve as useful hypothesis generation for continued examination of depression in youth anxiety IP studies, especially as assessment of depression may relate to the developmental trajectory of internalizing disorders and maintenance or worsening of IP biases over time.

Limitations and future directions

Several study-specific limitations of this dissertation should be noted. First, this was a cross-sectional correlational study, which limits the ability to make causal inferences about the directionality of associations. Second, the sample size in this dissertation was small, which may have impacted power and the ability to detect effects. Third, the sample included youths from a wide age range, different anxiety disorders, and variability in level of depression symptoms and secondary diagnoses. Again, this may have introduced additional variability into the sample, making it difficult to detect effects, especially pertaining to attention bias. We attempted to reduce variability by only including those youths with primary DSM-IV-TR anxiety disorders that are conceptualized similarly in the youth anxiety literature, excluded youths with any co-occurring problems that might impact findings, and ensured that all youths were able to read at age level and accurately completed performance-based tasks. However, substantial and significant relationships were found in this investigation, suggesting that some effects under investigation might be large enough to be detected even despite these limitations.

This work extends the current literature by providing the first test of relationships between performance-based attention and performance-based interpretation in a sample of clinically anxious youths. As hypothesized, it is also the first to identify performance-

based interpretation as substantially and significantly related to anxiety severity, with reaction times for rejecting benign interpretations related to youth-reported anxiety symptoms. Secondarily, this is the first study to examine relationships between attention bias to happy faces and reaction times for rejecting benign interpretations as significantly related to depressive symptoms in anxious youths. Findings have several implications for theory and future empirical investigations. Continued empirical investigations of attention and interpretation biases in anxiety disordered youths, with assessment of depressive symptoms and comparisons of positive/benign and negative stimuli, might clarify whether and how attentional processes play a role in the development and/or maintenance of anxiety. Additional studies of performance-based interpretation might provide useful knowledge about the stability of interpretation as a predictor of anxiety. These, in turn, might inform future modifications to IP theory as it applies to youth anxiety. A better understanding of attention and interpretation processes in clinically anxious youths will also inform how best to target IP through cognitive bias modification as a means to treat anxiety disorders in youths. The youth IP literature as it stands still leaves open mechanistic questions about these basic cognitive processes, despite evidence that interventions targeting these processes are demonstrating clinically and statistically significant effects on symptoms (e.g., Rozenman, Weersing, & Amir, 2011; Eldar et al., 2012). These mechanistic questions fundamentally limit our theoretical understanding and ability to treat youth anxiety disorders (Kazdin, 2007), as there is still no clear and consistent evidence of the causal or mediating roles of attention and interpretation in the development and maintenance of youth anxiety disorders. Future work to understand basic cognitive processes in youth anxiety will allow us to refine

cognitive bias modification interventions to appropriately target basic cognition and personalize the treatment of anxiety disorders in youths.

REFERENCES

Amir, N., Beard, C., Cobb, M., & Bomyea, J. (2009). Attention modification program in individuals with generalized anxiety disorder. *Journal of Abnormal Psychology, 118,* 28-33.

Amir, N., Beard, C., & Przeworski, A. (2005). Resolving ambiguity: The effect of experience on interpretation of ambiguous events in generalized social phobia. *Journal of Abnormal Psychology, 114,* 402-408.

Amir, N., Bomyea, J., & Beard, C. (2010). The effect of single-session interpretation modification on attention bias in socially anxious individuals. *Journal of Anxiety Disorders, 24,* 178-182.

Angold, A., Costello, E. J., & Erkanli, A. (1999). Comorbidity. *Journal of Child Psychology, Psychiatry, and Allied Disciplines, 40*, 57-87.

Bar-Haim, Y. (2010). Research review: Attention bias modification (ABM): A novel treatment for anxiety disorders. *Journal of Child Psychology and Psychiatry, 51,* 859-870.

Bar-Haim, Y., Lamy, D., Pergamin, L., Bakermans-Kranenburg, M. J., & Van Ijzendoorn, M. H. (2007). Threat-related attentional bias in anxious and nonanxious individuals: A meta-analytic study. *Psychological Bulletin, 133*, 1-24.

Barrett, P. M., Rapee, R. M., Dadds, M. M., & Ryan, S. M. (1996). Family enhancement of cognitive style in anxious and aggressive children. *Journal of Abnormal Child Psychology, 24,* 187-203.

Beard, C. & Amir, N. (2008). A multi-session interpretation modification program: Changes in interpretation and social anxiety symptoms. *Behaviour Research and Therapy, 46,* 1135-1141.

Beard, C. & Amir, N. (2009). Interpretation in social anxiety: When meaning precedes ambiguity. *Cognitive Therapy and Research, 33,* 406-415.

Beard, C. & Amir, N. (2010). Negative interpretation bias mediates the effect of social anxiety on state anxiety. *Cognitive Therapy and Research, 34,* 292-296.

Beesdo, K., Knappe, S., & Pine, D. S. (2009). Anxiety and anxiety disorders in children and adolescents: Developmental issues and implications for DSM-V. *Psychiatric Clinics of North America, 32,* 483-524.

Bell-Dolan, D. J., Last, C. G., & Strauss, C. C. (1990). Symptoms of anxiety disorders in normal children. *Journal of the American Academy of Child & Adolescent Psychiatry, 29*, 759-765.

Birmaher, B., Brent, D. A., Chiappetta, L., Bridge, J., Monga, S., & Baugher, M. (1999). Psychometric properties of the Screen for Child Anxiety Related Emotional Disorders scale (SCARED): A replication study. *Journal of the American Academy of Child and Adolescent Psychiatry, 38,* 1230-1236.

Birmaher, B., Ryan, N. D., Williamson, D. E., Brent, D. A., Kaufman, J., Dahl, R. E., Perel, J., & Nelson, B. (1996). Childhood and adolescent depression: A review of the past 10 years, Part I. *Journal of the American Academy of Child and Adolescent Psychiatry, 35,* 1427-1439.

Bittner, A., Egger, H. L., Erkanli, A., Costello, E. J., Foley, D. L., & Angold, A. (2007). What do anxiety disorders predict? *Journal of Child Psychology and Psychiatry, 48,* 1175-1183.

Bradley, B. P., Mogg, K., Falla, S. J., & Hamilton, L. R. (1998). Attentional bias for threatening facial expressions in anxiety: Manipulations of stimulus duration. *Cognition and Emotion, 12,* 737-53.

Chelminski, I. & Zimmerman, M. (2003). Pathological worry in depressed and anxious patients. *Journal of Anxiety Disorders, 17,* 533-546.

Compton, S. N., March, J. S., Brent, D., Albano, A. M., Weersing, V. R., & Curry, J. (2004). Cognitive-behavioral psychotherapy for anxiety and depressive disorders in children and adolescents: An evidence-based medicine review. *Journal of the American Academy of Child and Adolescent Psychiatry, 43,* 930-959.

Constans, J., Penn, D., Ihen, G., & Hope, D. (1999). Interpretive biases for ambiguous stimuli in social anxiety. *Behavior Research and Therapy, 37,* 643-651.

Crick, N. R. & Dodge, K. A. (1994). A review and reformulation of social information-processing mechanisms in children's social adjustment. *Psychological Bulletin, 115,* 74-101.

Dadds, M. R., Holland, D. E., Laurens, K. R., Mullins, M. Barrett, P. M., & Spence, S. H. (1999). Early intervention and prevention of anxiety disorders in children: Results at a 2-year follow-up. *Journal of Consulting and Clinical Psychology, 67,* 145-150.

Daleiden, E. L. & Vasey, M. W. (1997). An information-processing perspective on childhood anxiety. *Clinical Psychology Review, 17,* 407-429.

Dalgleish, T., Taghavi, R., Neshat-Doost, H., Moradi, A., Canterbury, R., & Yule, W. (2003). Patterns of processing bias for emotional information across clinical disorders: A comparison of attention, memory, and prospective cognition in children and adolescents with depression, generalized anxiety, and posttraumatic stress disorder. *Journal of Clinical Child and Adolescent Psychology, 32,* 10-21.

de Hullu, E., de Jong, P. J., Sportel, B. E., & Nauta, M. H. (2011). Threat-related automatic assuociations in socially anxious adolescents. *Behaviour Research and Therapy, 49,* 518-522.

Eldar, S., Apter, A., Lotan, D., Perez Edgar, K., Naim, R., Fox, N. A., Pine, D. S., & Bar-Haim, Y. (2012). Attention bias modification treatment for pediatric anxiety disorders: A randomized controlled trial. *American Journal of Psychiatry, 169,* 213-220.

Efron, B. & Tibshirani, R. J. (1993). An introduction to the bootstrap. New York: Chapman & Hall.

Ellenbogen, M. A. & Schwartzman, A. E. (2009). Selective attention and avoidance on a pictorial cueing task during stress in clinically anxious and depressed participants. *Behaviour Research and Therapy, 47,* 128-138.

Fritz, M. S. & MacKinnon, D. P. (2007). Required sample size to detect the mediated effect. *Psychological Science, 18,* 233-239.

Gotlib, I. H., Krasnoperova, E., Yue, D. N. & Joormann, J. (2004). Attentional biases for negative interpersonal stimuli in clinical depression. *Journal of Abnormal Psychology, 113,* 127-135.

Hadwin, J., Frost, S., French, C. C., & Richards, A. (1997). Cognitive processing and trait anxiety in typically developing children: Evidence for an interpretation bias. *Journal of Abnormal Psychology, 106,* 486-490.

Hakamata, Y., Lissek, S., Bar-Haim, Y., Britton, J. C., Fox, N., A., Leibenluft, E., Ernst, M., & Pine, D. S. (2010). Attention bias modification treatment: A meta-analysis toward the establishment of novel treatment for anxiety. *Biological Psychiatry, 68,* 982-990.

Hirsch, C. & Matthews, A. (2000). Impaired positive inferential bias in social phobia. *Journal of Abnormal Psychology, 109,* 705-712.

Hunt, C., Keogh, E., & French, C. C. (2007). Anxiety sensitivity, conscious awareness and selective attentional biases in children. *Behaviour Research and Therapy, 45,* 497-509.

Huppert, J. D., Foa, E., Fur, J. M., Filip, J. C., & Mathews, A. (2003). Interpretation bias in social anxiety: A dimensional perspective. *Cognitive Therapy and Research, 27,* 569-577.

In-Albon, T., Dubi, K., Rapee, R., & Schneider, S. (2009). Forced choice reaction time paradigm in children with separation anxiety disorder, social phobia, and nonanxious controls. *Behaviour Research and Therapy, 47,* 1058-1065.

In-Albon, T., Klein, A., Rinck, M., Becker, E., & Schneider, S. (2008). Development and evaluation of a new paradigm for the assessment of anxiety disorder-specific interpretation bias using picture stimuli. *Cognition and Emotion, 22,* 422-436.

Ingram, R. E. (1989). Unique and shared cognitive factors in social anxiety and depression: Automatic thinking and self-appraisal. *Journal of Social and Clinical Psychology, 8,* 198-208.

Kujawa, A. J., Torpey, D., Kim, J., Hajcak, G., Rose, S., Rose, S., Gotlib, I. H., & Klein, D. N. (2011). Attentional biases for emotional faces in young children of mothers with chronic or recurrent depression. *Journal of Abnormal Child Psychology, 39,* 125-135.

Kaufman, J., Birmaher, B., Brent, D., Rao, U., Flynn, C., Moreci, P., Williamson, D., & Ryan, N. (1997). Schedule for Affective Disorders and Schizophrenia for School-Age Children-Present and Lifetime version (K-SADS-PL): Initial reliability and validity data. *Journal of the American Academy of Child & Adolescent Psychiatry, 36*, 980-988.

Kazdin, A. E. (2007). Mediators and mechanisms of change in psychotherapy research. *Annual Review of Clinical Psychology, 3,* 1-27.

Keller, M., Lavori, P., Wunder, J., Beardslee, W., Schwartz, C., & Roth, J. (1992). Chronic course of anxiety disorders in children and adolescents. *Journal of the American Academy of Child and Adolescent Psychiatry, 31,* 595-599.

Kendall, P. C., Stark, K. D., & Adam, T. (1990). Cognitive deficit or cognitive distortion of childhood depression. *Journal of Abnormal Psychology, 18,* 255-270.

Kindt, M., Brosschot, J. F., & Everaerd, W. (1997). Cognitive processing bias of children in a real life stress situation and a neutral situation. *Journal of Experimental Child Psychology, 64,* 79-97.

Kingery, J. N., Roblek, T. L., Suveg, C., Grover, R. L., Sherrill, J. T., & Bergman, R. L. (2006). They're Not Just 'Little Adults': Developmental Considerations for Implementing Cognitive-Behavioral Therapy With Anxious Youth. *Journal of Cognitive Psychotherapy, 20,* 263-273.

Ladouceur, C. D., Dahl, R. E., Williamson, D. E., Birmaher, B., Ryan, N. D., & Casey, B. J. (2005). Altered emotional processing in pediatric anxiety, depression, and comorbid anxiety-depression. *Journal of Abnormal Child Psychology, 33,* 165-177.

Last, C. G., Hansen, C., & Franco, N. (1997). Anxious children in adulthood: A prospective study of adjustment. *Journal of the American Academy of Child & Adolescent Psychiatry, 36,* 645-652.

Legerstee, J. S., Tulen, J. H. M., Kallen, V. L., Dieleman, G. C., Treffers, P. D. A., Verhulst, F. C., & Utens, E. M. (2009). Threat-related selective attention predicts treatment success in childhood anxiety disorders. *Journal of the American Academy of Child and Adolescent Psychiatry, 48,* 196-205.

MacKinnon, D. P., Lockwood, C. M., Hoffman, J. M., West, S. G., & Sheets, V. (2002). A comparison of methods to test mediation and other intervening variable effects. *Psychological Methods, 7,* 83-104.

MacLeod, C., Mathews, A., & Tata, P. (1986). Attentional bias in emotional disorders. *Journal of Abnormal Psychology, 111,* 107-123.

March, J. S. (2011). Attention Bias Modification Training and the new interventions research. *Biological Psychiatry, 68,* 978-979.

Mathews, A. & MacLeod, C. (2005). Cognitive vulnerability to emotional disorders. *Annual Review of Clinical Psychology, 1,* 167-195.

Matsumoto, D. & Ekman, P. (1989). American-Japanese cultural differences in intensity ratings of facial expressions of emotion. *Motivation and Emotion, 13,* 143-157.

Miers, A. C., Blote, A. W., Bogels, S. M., & Westenberg, P. M. (2008). Interpretation bias and social anxiety in adolescents. *Journal of Anxiety Disorders, 22,* 1462-1471.

Mogg, K. & Bradley, B. P. (2005). Attentional bias in generalized anxiety disorder versus depressive disorder. *Cognitive Therapy and Research, 29,* 29-45.

Muris, P. & Field, A. P. (2008). Distorted cognition and pathological anxiety in children and adolescents. *Cognition & Emotion, 22,* 395-421.

Neshat-Doost, H. T., Moradi, A. R., Taghavi, M. R., Yule, W., & Dalgleish, T. (2000). Lack of attentional bias for emotional information in clinically depressed children and adolescents on the dot probe task. *Journal of Child Psychology and Psychiatry, 41,* 363-368.

Possel, P., Seemann, S., Ahrens, S., & Hautzinger, M. (2006). Testing the causal mediation component of Dodge's social information processing model of social competence and depression. *Journal of Youth and Adolescence, 35,* 849-959.

Poznanski, E.O., & Mokros, H.B. Children's Depression Rating Scale – Revised, manual. Los Angeles: Western Psychological Services. 1996.

Preacher, K. J. & Hayes, A. F. (2008). Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behavior Research Methods, 40,* 879-891.

Puliafico, A. C. & Kendall, P. C. (2006). Threat-related attentional bias in anxious youth: A review. *Clinical Child and Family Psychology Review, 9,* 162-180.

Reinherz, H. Z., Giaconia, R. M., Hauf, A. M., Wasserman, M. S. & Silverman, A. B. (1999). Major depression in the transition to adulthood: Risks and impairments. *Journal of Abnormal Psychology, 108,* 500-510.

Roy, A. K., Vasa, R. A., Bruck, M., Mogg, K., Bradley, B. P., Sweeney, M., Bergman, R. L., McClure-Tone, E. B., Pine, D. S., & CAMS Team. (2008). Attention bias toward threat in pediatric anxiety disorders. *Journal of the American Academy of Child & Adolescent Psychiatry, 47,* 1189-1196.

Roza, S. J., Hofstra, M. B., van der Ende, J., & Verhulst, F. C. (2003). Stable prediction of mood and anxiety disorders based on behavioral and emotional problems in childhood: A 14-year follow-up during childhood, adolescence, and young adulthood. *American Journal of Psychiatry, 160,* 2116-2121.

Rozenman, M., Weersing, V. R., & Amir, N. (2011). A case series of attention modification in clinically anxious youths. *Behaviour Research and Therapy, 49,* 324-330.

Rozenman, M., Weersing, V. R., & Amir, N. Cognitive Bias Modification in internalizing youths: An integrative review and intervention recommendations. *Manuscript in preparation.*

Rozenman, M., Bettis, A., Goldberg, L., Amir, N., & Weersing, V. R. Psychometric properties of a performance-based interpretation bias measure in youths. Poster presented at the 91st Western Psychological Association (WPA) annual convention, Los Angeles, CA, April 2011.

Schaffer, D., Fisher, P., Dulcan, M. K., & Davies, M. (1996). The NIMH Diagnostic Interview Schedule for Children Version 2.3 (DISC-2.3): Description, acceptability, prevalence rates, and performance in the MECA study. *Journal of the American Academy of Child and Ado*lescent Psychiatry, 35, 856-877.

Schniering, C. A. & Rapee, R. M. (2002). Development and validation of a measure of children's automatic thoughts: The Children's Automatic Thoughts Scale. *Behaviour Research & Therapy, 40,* 1091-1109.

Stopa, L. & Clark, D. (2000). Social phobia and interpretation of social events. *Behavior Research and Therapy, 38,* 273-283.

Taghavi, M.R., Neshat-Doost, H. T., Moradi, A. R., Yule, W., & Dalgleish, T. (1999). Biases in visual attention in children and adolescents with clinical anxiety and mixed anxiety-depression. *Journal of Abnormal Child Psychology, 27,* 215-233.

Taylor, C. T., Bomyea, J., & Amir, N. (2010). Attentional bias away from positive social information mediates the link between social anxiety and anxiety vulnerability to a social stressor. *Journal of Anxiety Disorders, 24,* 403-408.

The Research Units on Pediatric Psychopharmacology Anxiety Study Group. (2002). The Pediatric Anxiety Rating Scale (PARS): Development and psychometric properties. *Journal of the American Academy of Child and Adolescent Psychiatry, 41*, 1061-1069.

Waters, A. M., Henry, J., Mogg, K., Bradley, B. P., Pine, D. S. (2010). Attentional bias towards angry faces in childhood anxiety disorders. *Journal of Behavior Therapy and Experimental Psychiatry, 41*, 158-164.

Waters, A. M., Lipp, O. V. (2008). Visual search for emotional faces in children. *Cognition and Emotion, 22,* 1306-1326.

Waters, A. M., Lipp, O. V., & Spence, S. H. (2004). Attentional bias toward fear-related stimuli: An investigation with nonselected children and adults and children with anxiety disorders. *Journal of Experimental Child Psychology, 89,* 320-337.

Waters, A. M., Mogg, K., & Bradley, B. P. (2012). Direction of threat attention bias predicts treatment outcome in anxious children receiving cognitive-behavioural therapy. *Behaviour Research and Therapy, 50*, 428-434.

Waters, A. M., Mogg, K., Bradley, B. P., & Pine, D. S. (2011). Attention bias for angry faces in children with social phobia. *Journal of Experimental Psychopathology, 2,* 475-289.

Waters, A. M., Mogg, K., Bradley, B. P., & Pine, D. S. (2008). Attentional bias for emotional faces in children with generalised anxiety disorder. *Journal of the American Academy of Child and Adolescent Psychiatry, 47,* 435-442.

Waters, A. M., Wharton, T. A., Zimmer-Gembeck, M. J., & Craske, M. G. (2008). Threat-based cognitive biases in anxious children: Comparisons with non-anxious children before and after cognitive behavioural treatment. *Behaviour Research and Therapy, 46*, 358-374.

Watts, S. E. & Weems, C. F. (2006). Associations among selective attention, memory bias, cognitive errors and symptoms of anxiety in youth. *Journal of Abnormal Child Psychology, 34,* 841-852.

Weisz, J. R., & Weersing, V.R. (1999). Psychotherapy with Children and Adolescents: Efficacy, Effectiveness, and Developmental Concerns. In D.A.T. Cicchetti & Sheree L. (Eds.), *Developmental Approaches to Prevention and Intervention*: Vol. 9 (pp. 341-386). Rochester, NY: University of Rochester Press.

Wilkinson, G. S. & Robertson, G. J. (2006). Wide Range Achievement Test – Fourth Edition. Lutz, FL: Psychological Assessment Resources.

Wood, A., Kroll, L., Moore, A., & Harrington, R. (1995). Properties of the Mood and Feelings Questionnaire in adolescent psychiatric outpatients: A research note. *Journal of Child Psychology and Psychiatry, 36,* 327-334.

Woodward, L. J., Fergusson, D. M. (2001). Life course outcomes of young people with anxiety disorders in adolescence. *Journal of the American Academy of Child and Adolesccent Psychiatry, 40,* 1086-1093.