Age Differences in Information Processing Biases in Spider Fear

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This study investigated biases in interpretation (e.g., evaluation of the dangerousness of spiders) and memory (preferential recall of spider stimuli) in spider fearful and non-fearful children ($n = 59$; ages 9–11) and young adults ($n = 61$; ages 18–21). Of interest were: (a) whether biases are present in high fear persons, and (b) whether biases can predict subjective distress and avoidance in response to a feared stimulus. Results showed that spider specific interpretation and memory biases are present in high fear adults, but not in high fear children. Only the spider specific interpretation bias significantly predicted anxious responding on its own, and did so in adults only. Findings are discussed in terms of cognitive models of anxiety, as well as developmental and methodological considerations that may have made it difficult to observe biased processing in the child sample.

General cognitive models of anxiety predict that individuals suffering from extreme fear and anxiety will demonstrate biases in the ways they attend to, interpret, and remember information (e.g., Beck & Emery, with Greenberg, 1985). These models have improved our understanding about the onset, maintenance, and treatment of anxiety difficulties. However, cognitive models have primarily focused on describing biased processing in anxious adults. Yet, the early and chronic course of many anxiety disorders (Newman et al., 1996; see review by Cartwright-Hatton, McNicol, & Doubleday, 2006) suggests that further research exploring information processing biases in childhood anxiety is needed.

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Despite the abundance of research on information processing in anxious adults (see Mathews & MacLeod, 2005), theoretical contributions that speak directly to cognitive processing in anxious children are more limited. Some researchers have proposed that anxiety disorders may be less focused and cognitively coherent during childhood (Muris, 2007), resulting in less specific cognitive distortions in young children (Muris & Field, 2008). Along these lines, unlike the relatively consistent evidence for greater attention and interpretation biases in processing potential threat cues among highly anxious (compared to non-anxious) adults (see Mathews & MacLeod, 2005), results in children have been more mixed. For instance, some studies found an anxiety-linked bias toward threat (e.g., Hadwin, Frost, French, & Richards, 1997; Martin, Horder, & Jones, 1992), while others showed comparable evidence for selective processing of threat information in all children, regardless of their fear level (e.g., Kindt, Bierman, & Brosschot, 1997; Kindt, Brosschot, & Everaerd, 1997; Kindt, van den Hout, de Jong, & Hoekzema, 2000).

These mixed findings may be partly linked to the age at which the child was measured, and the match between the child’s particular fears and the threat stimuli used in the tasks. In fact, Kindt and colleagues’ (e.g., Kindt & van den Hout, 2001) cognitive inhibition theory, one of the few strictly developmental theories of information processing in anxiety, suggests that both anxious and non-anxious children show a broad bias for selectively processing threatening information, rather than a bias specific to a particular situation (see Hadwin & Field, 2010). According to this theory, bias toward threat in younger children may simply reflect a developmental inability to inhibit the processing of threat related information, which is expected to improve between the ages of 7 and 11. Thus, it is the continuation of selective attention to threat in anxious children into early adolescence that may serve as a vulnerability factor for later difficulties with anxiety (Kindt & van den Hout, 2001). While the cognitive inhibition theory has considerable developmental appeal as a means of explaining the mixed information processing findings in the child literature (Kindt & van den Hout, 2001), empirical support for this theory has been somewhat inconsistent (e.g., Morren, Kindt, van den Hout, & van Kasteren, 2003).

Making sense of the mixed findings across studies is challenging, in part because studies have varied in terms of the processing bias investigated (typically only looking at a single interpretation, memory, or attention bias), the heterogeneity among and within the fearful samples (e.g., mixed anxiety disorder diagnoses, nonclinical samples), as well as the specificity of the threat stimuli (i.e., whether the threat stimuli used were matched to the individual’s fear). Thus, examining multiple information processing biases among more homogenous high and low fear adults and children (and focusing particularly in later childhood when we might see the continuation of selective processing of threat cues in vulnerable children) may help determine whether fearful children have similar biases to those...
seen in fearful adults. Similarly, including stimuli that match the individual’s fear, as well as non-matching, alternate threat stimuli can help shed light on the specificity of processing biases in childhood. The current study uses this framework to test interpretation and memory biases.

Interpretation biases refer to the tendency of anxious individuals to interpret ambiguous information in a threatening manner when compared to non-anxious individuals. Research examining interpretation biases in anxious children shows a pattern similar to that observed in anxious adults (e.g., Butler & Mathews, 1983) in that anxious children also exhibit a tendency to interpret ambiguous information in a threatening way (e.g., Hadwin et al., 1997; Taghavi, Moradi, Neshat-Doost, Yule, & Dalgleish, 2000). However, while the use of story-based interpretation paradigms supports the existence of information processing biases in children with specific fears in some cases (e.g., social anxiety; Muris, Merckelbach, & Damsma, 2000), this finding has not been consistent (e.g., Muris, Kindt, et al., 2000), and no studies to our knowledge have tested the specificity of these interpretation biases in spider fear.

Memory biases refer to the tendency for anxious individuals to exhibit selective recall or recognition for threat-relevant information. Thus far, the few studies examining threat-relevant memory biases in anxious children have produced mixed results (see Muris & Field, 2008, for a brief review). Importantly, inconsistent findings have also been the norm in anxious adult samples, including in spider phobia (e.g., Olatunji, Sawchuk, Lee, Lohr, & Tolin, 2008; Sawchuk, Meunier, Lohr, & Westendorf, 2002; Thorpe & Salkovskis, 2000; Wenzel, Jostad, Brendle, Ferraro, & Lystad, 2004). The discrepant memory findings are difficult to understand, especially in light of the more well-established presence of fear-relevant attention (e.g., spider phobia: Lavy, van den Hout, & Amtz, 1993; Watts, McKenna, Sharrock, & Trezise, 1986; for a review see Williams, Watts, MacLeod, & Mathews, 1997) and interpretation biases. It seems likely that past mixed findings may be partly explained by inadequate activation of the biases in the experimental paradigms (see Coles & Heimberg, 2002), among a number of other factors.

CURRENT STUDY

In the present study, biases were examined in children and young adults who were high versus low in spider fear, a relatively common problem in childhood and adolescence (e.g., Lane & Gullone, 1999; Muris, Merckelbach, & Collaris, 1997). Spider fear was selected because of its high prevalence in these age groups, and because of the ability to select clear, disorder-relevant cues to use for the information processing tasks (i.e., spider stimuli). However, we expect that the questions investigated concerning age differences in selective processing biases are relevant across many different fear and anxiety domains.

We examined interpretation and memory processing biases in a homogenous sample (all high or low in spider fear), and we tested spider-relevant biases and spider-irrelevant biases in a different threat domain. This design was intended to help determine whether biases generalize across fear domains and/or across
individual fear levels. It should be noted that the current study was not a direct test of the cognitive inhibition hypothesis (Kindt & van den Hout, 2001), which emphasized developmental changes in anxiety-linked attentional bias, but rather we used this theory to provide a framework for trying to understand and build on mixed results in the child information processing literature.

To maximize the ability to compare biases across age groups, the same information processing measures were used for both the children and adults, with minimal, age appropriate modified task instructions and stimuli (see Vasey, Dalgleish, & Silverman, 2003). Further a narrow age range (9–11 years) was used to minimize the impact of variability in the data due to highly discrepant developmental stages in the child sample. Additionally, this age range was chosen based on Kindt and van den Hout’s (2001) suggestion that ability to inhibit threat improves between ages 7 and 11, as well as based on prior research indicating that the peak period of normative fears is between ages 7 to 9, with fears declining between the ages of 10 and 12 (Muris, Merckelbach, Gadet, & Moulgaard, 2000). Given that the age range of the current child sample (ages 9–11) occurs when we might expect an improved ability to inhibit threat information, as well as at the latter end of the peak period of normative fears, we expected normative fears of spiders to be relatively low in our sample, with the highly spider fearful children maintaining their selective processing of threat-specific information. As noted, evidence for interpretation and memory biases was examined for both spider specific and an alternate threat category in the child and adult samples. We chose physical threat (e.g., threat of injury) as our alternate threat category because it is a common problem area, even among children (Campbell & Rapee, 1994), but very different from spider fear in terms of fear cues.

Interpretation biases were examined by having participants rate the likelihood of spider specific events (e.g., “The spider will attack you”; following de Jong & Muris, 2002) and by rank ordering the likelihood of general threat explanations related to physical concerns (e.g., “You feel short of breath. Why? . . .”; following Clark et al., 1997). We expected differences between the high and low fear groups for both the children and the adults on the spider specific bias measure (i.e., greater spider threat bias among the high fear groups, regardless of age). On the physical threat bias measure, we predicted that a small fear group difference may be evident among the children if the high fear children had not yet developed the requisite cognitive inhibition skills needed to reduce the general (i.e., non-spider specific) threat biases, per findings from Kindt et al. (2000). In contrast, no physical threat fear group difference was expected among the adult sample, given that even spider fearful adults are expected to have learned to inhibit concerns that are irrelevant to their specific accessible fear. Note, given findings of normative selective processing of spider (relative to neutral) information, even among unselected samples (see Öhman & Mineka, 2001), our hypotheses focused on the comparison between persons low and high in spider fear, rather than the absolute value of a spider versus neutral bias.

Examination of memory biases in the current study incorporated a prime (watching a video clip of spiders) to increase state anxiety prior to the memory
task (see Smith-Janik & Teachman, 2008). Matching the hypotheses for interpretation, we predicted that priming the concept of “spider” would result in preferential recall of spider specific information by the high (compared to low) fear group for both the children and the adults, and perhaps a small fear group difference in recall of physical threat information for the children, but not the adults.

The impact of biased interpretation and memory on ratings of anxious symptoms, specifically subjective distress and observed behavioral avoidance, was examined by having participants engage in a behavioral assessment test (BAT) that involved approaching a caged tarantula. Few studies have examined this type of predictive validity for information processing measures, especially among anxious children (see example in Teachman, 2007, with an adult sample), so extending the literature beyond tests of known group differences was deemed important. Spider specific processing biases were expected to predict greater anxious responding to the tarantula.

To our knowledge, this is the first study that assesses both spider specific and an alternate threat bias across multiple information processing tasks in both children and adults, and examines how information processing predicts anxious responding. This design will allow for comparisons across fear levels, age groups, threat stimuli, and type of processing bias.

METHOD

PARTICIPANTS

Participants were 59 children (39 girls) and 61 adults (44 women). The mean age of the child sample was 9.59 years ($SD = 0.83$; range = 9–11 years), and 80% reported race and/or ethnicity as Caucasian, 2% African American, 3% Asian, and 13% biracial. Two percent listed their race as “other.” The mean age of the adult sample was 18.8 years ($SD = 0.87$; range = 18–21 years) and 80% reported race/ethnicity as Caucasian, 5% African American, 5% Asian, and 10% biracial.

Children were recruited via flyers at local schools, psychological clinics, doctors’ offices, at extra-curricular activities (e.g., little league games), and local community events, as well as through other ongoing research studies and newspaper advertisements. Parents completed a brief phone interview about the intensity and duration of their child’s spider fear to determine study eligibility. Parents rated their child’s fear on a 5-point Likert scale ranging from 1 (not at all) to 5 (very much; following the scale by Wolpe & Lange, 1964). Children rated as a 1 or a 2 were assigned to the low fear group, and those rated as a 4 or 5, whose fear was excessive compared to peers, and who had a minimum fear duration of six months—per the Diagnostic and Statistical Manual-IV-Text Revision (DSM-IV-TR) specific phobia criteria (American Psychiatric Association, 2000)—were assigned to the high fear group. Previous research has relied on parent report of the child’s

1. Data from two adult participants were not included because they decided to discontinue participation in the study. Additionally, the parent of one child participant chose to have his/her child’s data removed.
mental health status to determine study inclusion (e.g., Waters, Lipp, & Spence, 2004). Fear groups were matched on gender, and the final sample included 59 children (28 = low fear, 31 = high fear).

The young adult sample included undergraduate students in the psychology department participant pool. All students in the pool completed the 9-item animal/insect fears subscale of the Fear Survey Schedule-III (FSS-III; the item “crawling insects” was replaced with “spiders”; Wolpe & Lang, 1964) as part of a pre-selection screening. The FSS-III assesses fears of animals on a 5-point Likert scale. Unlike the child participants, fear ratings were obtained for many animals to reduce demand characteristics. Participants rating their spider fear as a 1 (not at all) or 2 (a little; for the low fear group), or as a 5 (very much; for the high fear group) were invited to participate (following recruitment procedures from Teachman, Gregg, & Woody, 2001). High fear participants must have reported that their fear was excessive in comparison to peers and that it was present for at least six months, matching the criteria used for selecting the high fear children. High and low adult fear groups were also matched on gender, and the final adult sample included 61 participants (30 = low fear, 31 = high fear).

MATERIALS

Child Fear Measures. The Anxiety Disorders Interview Schedule, Child Version for DSM-IV (ADIS-C; Albano & Silverman, 1996) was used to assess number of criteria endorsed for specific phobia. It has good to excellent reliability for diagnoses of anxiety disorders and symptoms (Silverman, Saavedra, & Pina, 2001). Only the module to diagnose spider phobia was administered. In the current study, inter-rater reliability was excellent: $r = .93, p < .05$ (calculated using a bivariate correlation for a subset of the adult and children’s ADIS interviews; eight from each of the four age/fear groups).

The About My Child’s Fear of Spiders is a modified 5-item questionnaire used to obtain parent report of the child participants’ spider fear (Ollendick & Öst, 2005). Items are based on the relevant items in the specific phobia section of the Anxiety Disorders Interview Schedule, Parent Version for DSM-IV (ADIS-P; Albano & Silverman, 1996). Cronbach’s alpha in the current sample was .81.

The self-reported Spider Phobia Questionnaire for Children (SPQ-C; Kindt, Broschot, & Muris, 1996) was used to assess severity of spider fear. It has high internal consistency, adequate test-retest reliability, and good predictive validity (Kindt et al., 1996). Cronbach’s alpha for the current sample was .93.

Adult Fear Measures. The Anxiety Disorders Interview Schedule for DSM-IV (ADIS-IV; Brown, DiNardo, & Barlow, 1994) was used to assess specific phobia criteria and has good to excellent inter-rater reliability (Brown, DiNardo, Lehman, 2. The materials reported here are part of a larger study assessing a range of cognitive and emotional functioning measures related to spider fear. For a complete listing of measures, please contact the first author. Notably, a dot probe task assessing attention bias was also administered; however, due to extremely low reliability in both the child and adult samples (average split-half reliability: $r = .22$), these results are not reported here.
& Campbell, 2001). Only the module to diagnose spider phobia was administered (see description of child version for inter-rater reliability information).

The self-reported Spider Phobia Questionnaire (SPQ; Klorman, Weerts, Hastings, Melamed, & Lang, 1974) was used to measure fear of spiders. The SPQ has good psychometric properties (see Muris & Merckelbach, 1996), and Cronbach’s alpha was .95 in this study.

**Intellectual Functioning.** The vocabulary subtest of the Kaufman Brief Intelligence Test (K-BIT; Kaufman & Kaufman, 1990) was included as a brief screener of intellectual functioning for all participants to determine comparability of the child and adult samples and to check if group differences in information processing could be attributed to differences in general cognitive abilities.

### INFORMATION PROCESSING MEASURES

**Interpretation Task.** Spider specific biases were measured using the Spider Interpretation Questionnaire (SIQ; de Jong & Muris, 2002) via responses to a vignette. The vignette described a bedroom in which the participant was to imagine spending the night and seeing “a medium-sized house spider” above the door. Participants rated the likelihood that a spider would invade their personal space, approach, come in physical contact with, or cause harm to them. This task provided a measure of interpretation biases by presenting participants with an ambiguous situation involving spiders and measuring the extent to which they judged negative spider events as likely to occur. This was administered as a self-report measure for all participants. An English translation of the SIQ was provided from one of the original authors, and very minor wording modifications were made so that item content and language were developmentally appropriate for the child sample. A 5-point Likert scale ranging from 1 (not likely) to 5 (very likely) replaced the percent rating scale (0–100) initially used, given young children’s difficulty understanding percentages. Finally, the original SIQ contained two vignettes, but only one was used in the current study due to time constraints. Responses were scored according to methods in de Jong and Muris. The SIQ has shown satisfactory reliability and content validity, and Cronbach’s alpha for the current sample was .87.

Physical threat biases were assessed via responses to ambiguous physical events on the 7-item “panic body sensations” subscale of the Brief Body Sensations Interpretation Questionnaire (BBSIQ; Clark et al., 1997). Participants rank ordered three alternatives that reflected possible explanations for each event (e.g., explanations for a very rapid heartbeat). This was administered as a self-report measure for all participants. Language on the BBSIQ was slightly modified to reflect American versus British English, and modifications were made so item content and language were developmentally appropriate. Responses were scored according to methods in Clark et al. The BBSIQ has good internal consistency (Clark et al., 1997), though Cronbach’s alpha for the current sample was only .57.

**Memory Task.** A modified incidental free recall task (Becker, Rinck, & Margraf, 1994; Becker, Roth, Andrich, & Margraf, 1999) incorporating use of a prime
before the task (watching a 30-second video clip of spiders) was used, because primes have been found to enhance expression of memory biases in previous research (Smith-Janik & Teachman, 2008). While there is some controversy about the utility of state anxiety primes in enhancing biases (e.g., Mathews & Sebastian, 1993), use of a state anxiety prime in the current study was chosen, given its success in the authors’ previous research in enhancing memory bias with this paradigm (Smith-Janik & Teachman, 2008). Word categories included spider specific (fear-relevant), physical-concern (alternate, spider-irrelevant threat), and neutral words (control category: semantically related words consisting of articles of furniture), with 10 words per category. The spider specific and physical-concern words were obtained from previous research (Beck, Stanley, Averill, Baldwin, & Deagle, 1992; Kindt et al., 1997; Kindt & Brosschot, 1999; Watts & Dalgleish, 1991), with additional items generated by the authors’ lab. Neutral words were obtained from an updated version of the Battig and Montague category norms (Van Overschelde, Rawson, & Dunlosky, 2004). All stimuli were piloted with child participants and deemed familiar. Words were also pre-rated by members of the authors’ lab (N = 14) for ease of categorization and valence. Only words rated as at least moderately easy to categorize were included. There were no mean differences in valence between the spider specific and physical-concern words (p > .10), and both categories were more negatively valenced than the neutral word category (both p < .05). Stimuli lists are available from the first author.

At encoding, participants viewed a series of words on a computer monitor and were told to think about the word in relation to themselves and to rate the ease of imagining each word (see Becker et al., 1999), thus enhancing elaboration of the word stimuli. Participants were not informed that they would be asked to recall the words later. Words were presented in random order for 10 seconds each, and no more than three words from the same category were presented in sequence. To prevent rehearsal of the stimuli, a 3-minute distracter stage requiring assembly of an age-appropriate jigsaw puzzle followed encoding. To assess immediate word recall, participants were then given five minutes to recall as many of the words as they could remember. Responses were scored according to Smith-Janik and Teachman (2008). One hour later, delayed recall was assessed.

BEHAVIORAL ASSESSMENT TEST (BAT)

A behavioral assessment test (BAT) was used to assess fear and avoidance of a spider stimulus (modified from Teachman & Saporito, 2009). A harmless but large tarantula was in a cage at one end of a room, and participants were asked to enter the room and to approach the spider as closely as possible. The BAT included eight steps (open door and step into room, move progressively closer, stand next to cage, touch cage, etc.), with the final step involving touching the tarantula. Participants provided subjective ratings of distress for their peak anxiety during the task using the 8-point “Feelings Thermometer” (taken from the ADIS-C interview).
PROCEDURE

Participants came for one session lasting two hours for child participants and 1.5 hours for adults. Adult participants provided informed consent. Parents provided consent for their child, and children provided assent. Child and adult participants completed tasks in a fixed order: (1) information processing measures, (2) spider phobia questionnaire, (3) behavioral assessment task, (4) diagnostic interview, and (5) assessment of verbal intellectual functioning. The diagnostic interview was administered near the end of the study to avoid priming spider concerns prior to completion of the other measures. The information processing tasks were also administered in a fixed order—(1) immediate memory, (2) interpretation, and (3) delayed memory—to avoid contaminating recall on immediate memory for stimuli presented in the other information processing measures. Items were read/explained to children as needed. A trained research assistant then completed the diagnostic interview. Parents of the child participants completed the questionnaire About My Child’s Fear of Spiders. Reimbursement for adult participation included course credit or $20, and child participants received a $20 gift certificate to a bookstore for their participation.

RESULTS

DATA REDUCTION AND SAMPLE CHARACTERISTICS

Before beginning the planned analyses, self-reported fear of spiders was examined separately for the four groups to check for outliers and to confirm group allocation. One low fear adult participant was excluded, because the participant’s mean SPQ score was greater than 3 SDs above the low fear mean. The final adult sample included 60 participants (17 men, 43 women), 30 high fear and 30 low fear. No additional child participants were excluded. As expected, there were no gender differences across the four groups ($\chi^2 = 1.21, p > .10$), and there were no age or education differences between high and low fear groups within either the child or adult samples (all $p > .10$). Additionally, there were no differences in parents’ level of education across the four groups (mother’s education: $F_{(3, 114)} = 2.32, p > .05, \eta^2 = 0.06$; father’s education: $F_{(3, 112)} = 0.21, p > .10, \eta^2 = 0.01$). Finally, there were no differences in verbal abilities across the four groups as measured via the K-BIT, $F_{(3, 111)} = 0.33, p > .10, \eta^2 = 0.009$, further supporting the groups’ comparability on fear-irrelevant measures.

GROUP DIFFERENCES IN FEAR MEASURES

As expected, spider fearful children endorsed more items on the ADIS-C than did low fear children, $t_{(57)} = 8.05, p < .05, d = 2.13$. In the high fear sample, 68% met either four or all five of the criteria for a diagnosis of spider phobia. Spider fearful children also scored higher on self-reported spider fear than did low fear
children on the SPQ-C, \( t_{(57)} = 7.62, p < .05, d = 2.02 \) (High Fear: \( M = 14.09, SD = 6.40 \); Low Fear: \( M = 4.15, SD = 2.72 \)), and the high fear mean SPQ-C score in the current sample is within 1.25 \( SD \) of the mean score reported in other phobic samples,\(^3\) thus supporting the classification of our high fear child sample. Moreover, parents of spider fearful children endorsed more spider phobia criteria for their child on the About My Child’s Fear of Spiders questionnaire than did parents of low fear children, \( t_{(57)} = 32.13, p < .05, d = 8.51 \). The correlation between parent report on this questionnaire and child report on the ADIS was \( r = .71, p < .05 \).

Analogously, spider fearful adults endorsed significantly more items on the ADIS than low fear adults, \( t_{(58)} = 10.82, p < .05, d = 2.84 \), with 57% of the high fear adults meeting either four or all five of the criteria for a diagnosis of spider phobia. The high fear group also reported more self-reported spider fear (SPQ: \( t_{(58)} = 13.24, p < .05, d = 3.48 \); High Fear: \( M = 16.92, SD = 5.35 \); Low Fear: \( M = 3.13, SD = 1.98 \)) than did low fear adults, and the mean SPQ score was within 1 \( SD \) of the mean score reported in other phobic samples (Teachman & Woody, 2003, phobic means: SPQ = 19.69 ± 4.75).

Together, these findings support the fear group classification, and the comparability of the phobic analogue nature of the child and adult high fear samples (e.g., comparable symptom levels were observed in the high fear groups relative to age-matched phobic samples, and comparable rates of meeting 4 to 5 diagnostic criteria).

**FEAR AND AGE GROUP DIFFERENCES IN INFORMATION PROCESSING MEASURES**

*Interpretation.* Spider specific (on the SIQ) and physical threat (on the BBSIQ) interpretation biases were evaluated using univariate ANOVAs with Age Group and Fear Group as the between subjects factors. The SIQ and BBSIQ are similar in that they both measure interpretations of hypothetical situations, but they do not use equivalent formats; hence their examination using separate tests in this study. As expected, on the SIQ, there was a significant main effect for Age Group, \( F_{(1,115)} = 10.42, p < .05, \eta^2_p = .08 \), and Fear Group, \( F_{(1,115)} = 24.21, p < .05, \eta^2_p = .17 \), as well as an interaction between Age Group and Fear Group, \( F_{(1,115)} = 8.33, p = .05, \eta^2_p = .07 \). Follow-up Scheffe tests showed that high fear adults scored significantly higher on the spider specific interpretation bias than did the other three groups, indicating that high fear adults exhibit more spider specific bias than low fear adults, and more spider specific bias than both high and low fear children (all \( p < .05 \)). Contrary to predictions, a follow-up \( t \)-test revealed

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3. Mayer, Merckelbach, and Muris (1999) used a shortened, 15-item version of the SPQ-C. For comparison purposes, the mean and standard deviation of the SPQ-C in the current sample was also calculated using only these 15 items. Using the shortened version, the mean for Meyer et al.’s phobic sample was 9.75 ± 2.0. The mean of the current high fear sample is 7.29 ± 3.31. All further analyses using the SPQ-C use the full 29-item version.
no significant differences in spider specific interpretation scores between low and high fear children, \( t_{(57)} = 1.40, p > .10, d = 0.37 \).

Given that cognitive biases may not appear as consistently in anxious children as they do in adults (Muris & Field, 2008), due to anxiety disorders perhaps being less focused and cognitively coherent in children (Muris, 2007), we conducted a post hoc analysis to examine interpretation biases in only the most fearful children—the 15 whose spider fear score on the SPQ-C fell within one standard deviation of the mean of a diagnosed phobic sample (Mayer, Merckelbach, & Muris, 1999). Results suggested that the spider specific interpretation bias was evident when comparing this subsample of children to the low fear children, \( t_{(41)} = 2.34, p < .05, d = 0.73 \) (Low fear: \( M = 18.96, SD = 4.24 \); High fear: \( M = 24.2, SD = 10.41 \)).

Next, the univariate test examining physical threat (BBSIQ) interpretation biases revealed no significant main effect for Fear Group, \( F_{(1, 115)} = 0.15, p > .10, \eta^2 = .001 \), or for the interaction between Age Group and Fear Group, \( F_{(1, 115)} = 0.19, p > .10, \eta^2 = .002 \). However, there was a nonsignificant trend for a main effect of Age Group, \( F_{(1, 115)} = 3.47, p < .10, \eta^2 = .03 \), with children scoring higher than adults on interpretation biases related to physical concerns.

Thus, consistent with hypotheses, high fear adults exhibited an interpretation bias for spider specific information, but not for physical threat information, when compared to low fear adults. However, contrary to expectations, there were no significant differences in spider specific or physical threat interpretation biases between high and low fear children (see Table 1). As noted, there was a significant difference in the spider specific bias between high and low fear children when only the most highly fearful children were compared to the children low in fear. However, there was no significant physical threat bias when comparing this highly fearful group of children to those low in fear. Also, there was a nonsignificant trend for all children to show an interpretation bias for physical threat information when compared to adults.

**Memory.** To evaluate differences in recall across the three word categories (spider, physical-concern, and neutral), words that were correctly recalled from any of the three word categories but altered in some way (e.g., singular nouns recalled as plural) were also counted as correct (following Smith-Janik & Teachman, 2008). Group differences in word imagery ratings were then examined to rule out the possibility that any biases observed might be due to differences in the image-ability of the words across groups. A univariate ANOVA with Age Group and Fear Group as the between subjects factors revealed no group differences in imagery rating (\( p > .10 \) for main effects of Age Group, Fear Group, and the interaction). In addition, prior to beginning the planned analyses, the total number of words recalled across the age groups was examined. As expected, children recalled fewer words when compared to the adults at both time points (immediate: \( t_{(115)} = 10.43, p < .05, d = 1.94 \); delayed: \( t_{(113)} = 10.00, p < .05, d = 1.88 \)). Given the overall differences in word recall across the age groups, memory bias was examined separately for each age group using repeated measures ANOVAs with Fear Group as the
between subjects factor, and Word Type (recall of spider, physical-concern, and neutral words) and Time (immediate, delayed) as the within subjects factors. For adults, there was a significant effect for Word Type, \( F(2, 55) = 53.17, p < .001, \eta^2 = .66 \), with neutral words recalled more than spider words, which were in turn recalled more than physical-concern words (all \( p < .05 \)). In addition, there was the expected main effect of Time, \( F(1, 56) = 17.32, p < .001, \eta^2 = .24 \), with greater immediate than delayed recall. Of greatest interest, there were also non-significant trends for Fear Group, \( F(1, 56) = 3.89, p = .05, \eta^2 = .07 \), and the expected Fear Group by Word Type interaction, \( F(2, 55) = 2.58, p < .10, \eta^2 = .09 \). To understand the interaction, independent samples t-tests comparing the fear groups for each word type (averaged across time points) were conducted. As expected, spider fearful adults recalled more spider words than did low-fear adults, \( t(56) = 3.45, p = .001, d = 0.92 \). Further, this bias was specific to spider words, as the adult fear groups did not differ in their recall of physical-concern or neutral words (both \( p > .10 \)). As noted, the adult groups also showed elevated recall for neutral words; however, this finding is not surprising given the high frequency of words from this category in the English language. In terms of a fear group memory bias, it is the significant difference in the relative ratio of spider words recalled by the high fear adults when compared to low fear adults that is of specific interest.

For children, there was also a significant effect for Word Type, \( F(2, 54) = 92.61, p < .001, \eta^2 = .77 \), with neutral words recalled equally as frequently as spider words (both \( p > .10 \)), and both, in turn, recalled more than physical-concern words (both \( p < .001 \)). There was also the anticipated main effect of Time, \( F(1, 55) = 14.53, p < .001, \eta^2 = .21 \), with greater immediate than delayed recall. However,
unlike the adults, there was no main effect for Fear Group or interaction with Word Type in the child sample (both $p > .10$), suggesting no evidence for a memory bias for threat words among the fearful children (see Table 2). Further, there were no fear group differences when looking at memory biases in the subgroup of most fearful children compared to those low in fear ($p > .10$).

Overall, these memory findings indicate that, consistent with previous research (Smith-Janik & Teachman, 2008) and hypotheses, high spider fear adults show a bias for spider specific stimuli, but not for general threat information, when compared to low fear adults. Contrary to expectations, high and low fear children did not differ in recall of spider or general threat items. (See Tables 3 and 4 for the relationships between the interpretation and memory bias variables.)

### INFORMATION PROCESSING AS A PREDICTOR OF ANXIOUS RESPONDING

Multivariate ANOVAs were conducted within each age group to examine the independent and interacting contributions of the interpretation and memory biases as predictors of anxious responding (peak subjective distress and behavioral avoidance) beyond, or in interaction with, the expected prediction conferred by

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**TABLE 2. Mean Words Recalled by Group at Immediate and Delayed Recall**

<table>
<thead>
<tr>
<th>Word Stimulus Category</th>
<th>Total</th>
<th>Spider</th>
<th>Physical</th>
<th>Neutral</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group</td>
<td>$M$</td>
<td>$SD$</td>
<td>$M$</td>
<td>$SD$</td>
</tr>
<tr>
<td>Child Immediate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child-Low Fear</td>
<td>11.75</td>
<td>4.85</td>
<td>4.86</td>
<td>2.09</td>
</tr>
<tr>
<td>Child-High Fear</td>
<td>11.00</td>
<td>3.63</td>
<td>4.87</td>
<td>1.89</td>
</tr>
<tr>
<td>Delayed</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child-Low Fear</td>
<td>10.85</td>
<td>4.90</td>
<td>4.59</td>
<td>1.87</td>
</tr>
<tr>
<td>Child-High Fear</td>
<td>9.70</td>
<td>3.91</td>
<td>4.33</td>
<td>2.32</td>
</tr>
<tr>
<td>Adult Immediate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adult-Low Fear</td>
<td>18.14</td>
<td>3.81</td>
<td>6.14$^a$</td>
<td>1.71</td>
</tr>
<tr>
<td>Adult-High Fear</td>
<td>19.72</td>
<td>3.23</td>
<td>7.31$^b$</td>
<td>1.44</td>
</tr>
<tr>
<td>Delayed</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adult-Low Fear</td>
<td>16.90</td>
<td>3.75</td>
<td>5.52$^c$</td>
<td>1.70</td>
</tr>
<tr>
<td>Adult-High Fear</td>
<td>18.93</td>
<td>3.64</td>
<td>7.03$^c$</td>
<td>1.48</td>
</tr>
</tbody>
</table>

Note. Means with different subscripts differ at $p < .01$. These differences are between high and low fear adults only.
fear group. Thus, Fear Group was also included in the models as an independent predictor (to further establish the validity of the high fear samples by showing prediction of anxious responding), and in interaction terms with each of the processing biases. Spider specific and general threat biases were examined separately. The multivariate approach was selected because it permitted parsimonious and relatively conservative omnibus tests to evaluate whether it was appropriate to then conduct the follow-up tests.

**Adult Sample.** As expected, there were main effects for Fear Group, $F_{(2, 49)} = 4.68, p < .05$, $\eta^2 = 0.16$, and for the spider specific interpretation bias, $F_{(2, 49)} = 4.73, p < .05$, $\eta^2 = 0.16$, though no significant main effect for spider specific memory, $F_{(2, 49)} = 0.33, p > .10$, $\eta^2 = 0.01$. Consistent with hypotheses, the spider specific interpretation bias predicted both behavioral avoidance and peak anxiety (both $p < .05$), such that the higher the bias score, the fewer steps completed on the BAT and the greater the peak anxiety. The interactions between Fear Group and the processing biases were not significant, and the physical threat indicators did not predict anxious responding (all $p > .10$), suggesting the effect is particular to spider specific interpretation bias.

**Child Sample.** Fear Group significantly predicted anxious responding, $F_{(2, 50)} = 5.00, p < .05$, $\eta^2 = 0.17$, reaffirming the fearful nature of the child analogue sample, but the spider specific information processing biases did not contribute to anxious responding (interpretation: $F_{(2, 50)} = 0.57, p > .10$, $\eta^2 = 0.02$; memory: $F_{(2, 50)} = 0.72, p > .10$, $\eta^2 = 0.03$). The interactions between Fear Group and the processing biases were not significant, and the physical threat indicators did not predict anxious responding (all $p > .10$).

**Table 3. Correlations Among Information Processing Biases in Low and High Fear Adults**

<table>
<thead>
<tr>
<th>Measure</th>
<th>Memory I (spider)</th>
<th>Memory II (spider)</th>
<th>Memory I (physical)</th>
<th>Memory II (physical)</th>
<th>Interpretation (spider)</th>
<th>Interpretation (physical)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Memory I (spider)</td>
<td>1</td>
<td>.75*/.75*</td>
<td>.12/.11</td>
<td>.16/.28</td>
<td>-20/.11</td>
<td>-.10/-09</td>
</tr>
<tr>
<td>Memory II (spider)</td>
<td></td>
<td>.06/.01</td>
<td>-.05/.16</td>
<td>.16/.02</td>
<td>-.07/-31</td>
<td></td>
</tr>
<tr>
<td>Memory I (physical)</td>
<td></td>
<td></td>
<td>1</td>
<td>.84*/.87*</td>
<td>.10/.01</td>
<td>-.16/.07</td>
</tr>
<tr>
<td>Memory II (physical)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-07/.02</td>
<td>-.12/.06</td>
</tr>
<tr>
<td>Interpretation (spider)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.18/.46*</td>
</tr>
<tr>
<td>Interpretation (physical)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

*Note. The first correlation coefficient in each cell is for the low fear adult sample and the second is for the high fear adult sample. *Correlation is significant at $p < .05$. Memory I = total spider-specific or physical-threat words recalled at "immediate" time point; Memory II = total spider or physical-threat words recalled at "delayed" time point; Interpretation = spider-specific or physical-threat bias measured via the SIQ and BBSIQ, respectively.
This study investigated interpretation and memory biases in high and low spider fearful children and young adults to examine fear group differences in biases, as well as whether biases can predict subjective distress and avoidance of a feared stimulus. As expected, high fear adults did show spider specific, but not physical threat, biases in interpretation and memory, and the interpretation bias predicted anxious responding to a live tarantula. Contrary to expectations, there were no fear group differences in biases, or prediction of anxious responding by the biases, among children. The current findings provide additional support for the presence of spider specific biased processing in high fear adults, consistent with cognitive models of anxiety, but challenge the application of these models in children.

EVIDENCE FOR BIASED PROCESSING IN ADULT SAMPLE

The finding that the spider specific interpretation bias differentiated the fear groups and predicted anxious responding in the adult sample provides additional evidence for the independent role of fear-relevant information processing in predicting behavior (avoidance) and affect (elevated anxiety). Further, the finding of an adult fear group difference in spider specific memory is notable, given the difficulty establishing the presence of memory biases in the anxiety literature (see Coles & Heimberg, 2002). The memory findings are also consistent with previous work demonstrating a spider specific memory bias in fearful adults when spider fear has been primed (Smith-Janik & Teachman, 2008). Moreover, the finding of the bias at both immediate and delayed recall in the high fear adults suggests maintenance of the memory bias over time. Again, this pattern is consistent with cognitive models of anxiety that suggest that the cognitive frameworks employed

<table>
<thead>
<tr>
<th>Measure</th>
<th>Memory I (spider)</th>
<th>Memory II (spider)</th>
<th>Memory I (physical)</th>
<th>Memory II (physical)</th>
<th>Interpretation (spider)</th>
<th>Interpretation (physical)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Memory I (spider)</td>
<td>1</td>
<td>.86*/.79*</td>
<td>.43*/.34</td>
<td>.55*/.45*</td>
<td>-.24/.43*</td>
<td>.17/-55*</td>
</tr>
<tr>
<td>Memory II (spider)</td>
<td></td>
<td>.36/14</td>
<td>.40*/.44*</td>
<td>-.28/30</td>
<td>.25/-54*</td>
<td></td>
</tr>
<tr>
<td>Memory I (physical)</td>
<td></td>
<td></td>
<td>.90*/.64*</td>
<td>-.21/20</td>
<td>.01/-17</td>
<td></td>
</tr>
<tr>
<td>Memory II (physical)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interpretation (spider)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interpretation (physical)</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Note. The first correlation coefficient in each cell is for the low fear child sample and the second is for the high fear child sample. *Correlation is significant at p < .05. Memory I = total spider-specific or physical-threat words recalled at “immediate” time point; Memory II = total spider or physical-threat words recalled at “delayed” time point; Interpretation = spider-specific or physical-threat bias measured via the SIQ and BBSIQ, respectively.
by anxious individuals remain distorted over time. If these frameworks go unchallenged, they ultimately result in a default response style of biased information processing and anxiety-driven affective and behavioral responding. Given the models, it is surprising that the memory bias did not predict anxious responding when approaching the live spider, though it may be that selective recall is not a key predictor of distress and avoidance when actually faced with a spider (instead, it is the tendency to make threatening interpretations in the moment). A memory bias may be more predictive of anticipatory anxiety where prior recall has considerable opportunity to bias perception of an impending spider interaction.

MINIMAL PROCESSING BIASES IN CHILD SAMPLE

Spider Threat Bias. The absence of fear group differences in spider threat bias in the child sample is unexpected based on cognitive models of anxiety initially developed for adults (Beck et al., 1985). Heterogeneity of fear levels in the high fear group may partly explain the null results, given the significant difference in the spider-specific interpretation bias score when comparing the most highly fearful children to children low in fear. This finding seems to imply that fear-specific interpretation biases are only observable in children who express phobic levels of fear, suggesting either the need for larger clinical analogue samples (given the small effect sizes in this literature) or the use of clinically diagnosed samples when examining information processing biases in children (e.g., Bar-Haim et al., 2007). However, an analogous post hoc analysis looking at memory biases in the most fearful children did not find fear group differences, suggesting fear levels cannot fully explain the pattern of null results for the children. Moreover, the high fear sample was a strong phobic analogue, with more than two thirds of the high fear children meeting either four or all five of the criteria for a diagnosis of spider phobia (an even higher percentage than among the high fear adult sample).

Physical Threat Bias. The lack of fear group differences in physical threat bias is also notable. According to Campbell and Rapee (1994), children between the ages of six and nine years demonstrate particular concerns with physical threat (the alternate threat category used in the current study), and this concern is thought to diminish with age. We had wondered whether some of this non-spider specific threat bias would remain in the high fear child sample given their apparent difficulty outgrowing normative fears and comments by Kindt and van den Hout (2001) that the development of inhibition abilities continues until approximately age 11. However, our results suggest that even spider fearful 9–11 year-olds can inhibit physical threat information at levels comparable to non-fearful children. One reason why hypotheses following from Kindt and colleagues’ cognitive inhibition theory may not have been borne out in these data is that the current study examined interpretation and memory biases, whereas Kindt and colleagues’ theory was based on findings from tests of attention bias.

Memory Bias. The absence of memory findings in the child sample is not too surprising, given the mixed memory findings observed in anxious adults and the general paucity of research examining memory in anxious children. It seems likely
that developmental issues may make it difficult to observe memory biases in the child sample more generally. For instance, similar to some previous studies examining memory in children, we did observe floor effects in word recall for the physical-concern word category, thus reducing the possibility of exploring the role of non-spider specific threat memory biases in the child sample. Previous studies have attempted to address this issue by incorporating rehearsal techniques during encoding and/or informing child participants that they will be asked later to write down the words (Dalgleish et al., 2003). We chose not to use these techniques in the current study based on our desire to have the memory task consistent across age groups and our concern that cued-recall would result in ceiling effects in the adult sample. The fact that we did not experience such significant floor effects for the neutral and spider word categories in the child sample was encouraging and suggests that word recall can be an appropriate mechanism for examining fear-relevant memory in children.

CONCLUSIONS AND LIMITATIONS

Consistent with cognitive models of anxiety, anxious adults did exhibit fear-specific biases (and not general, non-spider specific threat biases) in information processing. Additionally, among adults, the interpretation bias toward spider-relevant stimuli did predict anxious responding. The measure of interpretation bias selected for the current study focuses primarily on biased explicit evaluations of the dangerousness of spiders. It will be interesting in future work to also examine the predictive validity of other components of the biases and alternate measurement approaches, such as homophone tasks (Davey, Bickerstaffe, & MacDonald, 2006), that may tap more online and less strategic interpretive biases.

Contrary to expectations, high fear children did not exhibit spider specific or non-spider specific (physical) threat biases. While some researchers have suggested that the absence of information processing biases in young children may indicate that cognitive processing is not important in the development of anxiety, the current findings suggest a more nuanced role for biased information processing in anxious children, in that biased processing may only be evident among the most intensely fearful children. More generally, it remains unclear under what circumstances (e.g., specific age and fear level, specificity of stimuli) children will exhibit difficulty inhibiting threat information.

The current findings should be interpreted in light of the study’s limitations. In particular, the cross-sectional design limits our ability to examine developmental changes in information processing, and this study used a clinical analogue, as opposed to diagnosed, sample. Also, though numerous efforts were made to ensure the child and adult samples were comparable on key characteristics (and the high fear child and adult symptom scores fell within comparable ranges for age-matched phobic samples), the different sampling methods across age groups may have introduced additional heterogeneity. Additionally, the age groups presumably differ in ways that could affect the expression of processing biases, such as duration of spider fear, but this is a somewhat unavoidable aspect of using a
developmental framework. Finally, it was somewhat challenging to develop age appropriate tasks that would successfully tap into information processing biases across both the adult and child samples. Though we tried to make only minor modifications to previously validated tasks, comparability across groups is nonetheless a challenge. The dynamic nature of cognitive processing capacities in childhood and adolescence, and how these changing capacities relate to anxious mood, clearly present methodological challenges that require further exploration.

REFERENCES


