ATTENTIONAL BIASES FOR THREAT AND UNFAMILIARITY IN BEHAVIOURALLY INHIBITED CHILDREN

by

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ABSTRACT

Two studies assessed information processing biases related to threat and novelty in school age children who differed in behaviourally inhibited temperament (BI). Study 1 (N = 40) assessed selective attention for threatening expressions in novel and familiar faces using the Dot Probe task. BI ratings were obtained using two self-report measures: the BIQ and BII. Children with higher BI exhibited a greater attentional bias towards threat (with no evidence for avoidance following initial vigilance), and responded faster to novel faces across trials. Study 2 (N = 188) attempted to replicate and expand on Study 1. The Dot Probe task had additional trials to directly assess potential attentional biases for novel faces, and the parent-report versions of the BIQ and BII were administered in addition to the self-report versions. The findings regarding selective attention for threat were inconsistent, and there was no evidence that response to novelty differed based on BI.

Keywords: behavioural inhibition; attentional bias; novelty; threat

This thesis is dedicated to my parents,

Barbara and Jerzy Szpunar

for their exceptional support throughout all my academic endeavours.

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INTRODUCTION

Behavioural Inhibition (BI) is a temperament style that was first examined in depth by Kagan and his colleagues (e.g., Kagan, Reznick, & Snidman, 1988). BI is defined as a characteristic way of responding where novel or challenging situations cause a child to feel anxious and distressed (Kagan, 1989). In such situations, BI children have been found to have a lower threshold for limbic and sympathetic nervous system arousal (Kagan, Reznick, & Snidman, 1988). These physiological responses are likely due to elevated amygdala reactivity which has been found in BI children (Kagan, 2001). This tendency towards high arousal and distress leads many BI children to avoid various unfamiliar settings and individuals (Schwartz, Wright, Shin, Kagan, & Rauch, 2003).

Research shows that approximately 15 to 20 percent of healthy toddlers are behaviourally inhibited (Kagan, 1997; Rubin & Asendorpf, 1993). BI has been found to have moderate heritability (DiLalla, Kagan, & Reznick, 1994) and moderate stability throughout childhood (e.g., Calkins, Fox, & Marshall, 1996; Kagan, Resnick, Snidman, Gibbons, & Johnson, 1988). While a good proportion of BI children do not remain inhibited throughout childhood, many are not able to overcome their fearfulness and rely on avoidant coping strategies. Perhaps most importantly, as a group, BI children have a considerably higher likelihood of developing anxiety disorders (Hirshfeld-Becker, Biederman, & Rosenbaum, 2004).

The notion that BI is an important risk factor in the development of anxiety disorders has been supported by several longitudinal (e.g., Biederman et al., 1993), familial (e.g. Manassis, Bradley, Goldberg, Hood, & Swinson, 1995; Rosenbaum et al., 1988; Rosenbaum et al., 1991), and retrospective studies (e.g., Reznick, Hegeman, Kaufman, Woods, & Jacobs, 1992). However, the mechanisms supporting this relationship are not well understood.

One important possibility is that BI children may process information with a bias towards threat cues, similar to anxious children (e.g. Vasey, Daleiden, Williams, & Brown, 1995) and adults (e.g. Vasey & Macleod, 2001). Research has shown that such information processing factors play a key role in the development and maintenance of anxiety (Vasey & Macleod, 2001). In particular, selective attention has been extensively researched in the anxiety literature. This is due to the recognition that what is attended to impacts all other aspects of information processing (Bugental, 1992) and plays an important role in emotion regulation and dysregulation (Wilson & Gottman, 1996; Lonigan & Phillips, 2001). For example, an individual who has a consistent attentional bias for signs of threat may come to perceive the world as a dangerous place. They are likely to expend more time and energy contemplating negative outcomes, which restricts the processing resources they have available for assessing safety relevant information or engaging in alternative coping strategies. Thus, they experience increased anxiety. This is not to imply that it would be psychologically healthy or adaptive to ignore all threatening information, as when individuals are faced with real danger it is important that they are alert and responsive to the threat. However, the difference between anxiety-prone and non-anxious individuals' processing of information is that the threshold at which anxious individuals interpret a stimulus as threatening and/or orient their attention to threat cues is lower (Wilson & MacLeod, 2003). Anxious children are prone to interpreting even ambiguous stimuli as threatening (Vasey & MacLeod, 2001). Because they are reactive to minor threats that do not pose a true danger to them, their attentional processing is less adaptive and potentially contributes to the development of psychopathology.

Lonigan and colleagues (2001) suggest that this attentional bias towards threatening information partially mediates the relationship between temperamental risk and the development of anxiety disorders (Lonigan & Phillips, 2001; Lonigan, Vasey, Phillips, & Hazen, 2004). There is some experimental evidence that provides support for the notion that selective attention for inconsequential threat has causal effects on anxiety. For instance, university students who were trained to focus their attention towards threatening stimuli were found to be more vulnerable to anxiety when they later participated in a stressful task (Mathews & MacLeod, 2002). In another study, a computer program aimed at retaining attentional biases away from threat was more effective in helping college student worriers than a placebo treatment (Hazen, Vasey, & Schmidt, 2002; as cited in Bijttebier, Vasey, & Braet, 2003).

Given that BI children are a population that is at risk for developing anxiety disorders, assessing whether they exhibit an attentional bias for mild threat would further add to our understanding of the etiology of anxiety. Behavioural observations and physiological measures are consistent with the notion that BI children are more highly reactive to minor threats and unfamiliar situations, which others may find to be neutral or even enjoyable (Kagan, 1997). Due to this increased sensitivity to these situations, it is expected that BI children will show selective attention for cues to threat, and potentially novelty.

Measures of Attentional Bias

The possibility of an attentional bias towards threat in BI children has previously been assessed using the Stroop procedure (Schwartz, Snidman, & Kagan, 1996; Kagan, Snidman, Zentner, & Peterson, 1999), which asks participants to name the colour in which threatening and neutral words are written. Delays in colour naming are assumed to reflect increased attention being allocated to the written word. Research using this procedure with BI individuals has yielded weak and inconsistent results. For example, Schwartz, Snidman, and Kagan (1996) administered the Stroop task to adolescents who had been classified as inhibited and uninhibited at two years of age. While they found no group mean response time differences for threatening and neutral words, they did find that the inhibited group had a higher frequency of threatening words among their longest latencies. It is possible that the failure to find group differences in attention to threat may have been due to the way in which the adolescents were classified. Past research indicates that BI has only moderate stability (e.g., Calkins, Fox, & Marshall, 1996; Kagan, Resnick, Snidman, Gibbons, & Johnson, 1988). Therefore, many of the adolescents who were classified as inhibited at age two may no longer have met the criteria at the time of the experiment. Kagan, Snidman, Zentner, and Peterson (1999) also administered the Stroop task using pictures to 7 year old children who had been classified as high reactive and low reactive at 4 months of age, some of whom exhibited anxious symptoms at the time of the experiment. In this study no significant differences between presently anxious and non-anxious children, or between previously classified high and low reactive children were revealed. Kagan and colleagues' (1999) failure to find the expected associations between Stroop interference and anxiety, reactivity, or other indices of fearfulness led them to question the validity of the assumptions underlying the meaning of the Stroop procedure (Kagan, Snidman, Zentner, & Peterson,1999).

The Stroop procedure has been criticized by other researchers as well. It is increasingly being recognized, for example, that cognitive interference on the Stroop task could be attributed to factors other than selective attention, such as emotional arousal (Vasey & MacLeod, 2001), and the mechanism underlying the Stroop procedure is unclear (Williams, Watts, MacLeod, & Mathews, 1997). Vasey and MacLeod (2001) also point out that studies with anxious children using the Stroop task have at times yielded inconsistent results. Whereas studies using another measure of attentional bias, the Dot Probe task, consistently detect an attentional bias for threatening information in anxious populations. This suggests that the Dot Probe is a more sensitive measure of attentional bias for threat.

The Dot Probe procedure is a cueing paradigm that provides a direct test of attention allocation. Typically, the trials in the Dot Probe task begin with a central fixation cross. This is followed by two simultaneously displayed words or pictures that reflect different emotions (e.g. threatening vs. neutral), which are most commonly presented for 500 milliseconds (ms). Immediately following these stimuli, a probe appears unpredictably in the location of one of the words and remains on the screen until the participant has identified where it is. Shorter latencies to detect probes appearing in the same location as the threat word, for example, are interpreted as evidence of attention allocation to the threat word. Conversely, consistently longer latencies to probes appearing on the opposite location as a threat word are interpreted as a result of attention being redirected from the position of the threat word to the probe position.

To date, attentional bias in BI children has not been assessed using the Dot Probe task. Due to the limitations noted in using the Stroop task, the Dot Probe procedure would provide a more informative means of assessing BI children's attention allocation. Further, the Dot Probe is currently one of the most popular methods for investigating selective attention in the anxiety literature (Yiend & Mathews, 2005). Therefore, the Dot Probe is the ideal choice for assessing whether the bias for threat found in anxious individuals will be replicated in other populations because it allows for clearer comparisons across studies.

Another important advantage of the Dot Probe task is that, unlike the Stroop task, it allows attention allocation to be measured after stimuli have been presented for different time intervals. This is desirable because the time course of the attentional bias in anxiety-prone populations is not well understood. Although the research findings have been mixed, several studies suggest that an initial attentional bias for threat is followed by a purposeful avoidance of threat at longer stimulus intervals (Calvo & Avero, 2005; Koster, Verschuere, Crombez, & Damme, 2005; Mogg, Bradley, Miles, & Dixon, 2004; Rohner, 2002). Specifically, attentional bias for threatening stimuli is generally found in anxious individuals at 500 ms (Bradley, Mogg, Falla, & Hamilton, 1998; Bradley, Mogg, & Miller, 2000; MacLeod, Mathews, & Tata, 1986; Mogg, Bradley, Miles, & Dixon, 2004). However, after ample time has been given for conscious and effortful strategies to be implemented, at roughly 1250 ms to 2000 ms, anxious individuals appear to avert their gaze from the location of the threat (Calvo & Pedro, 2005; Koster, Verschuere, Crombez, & Damme, 2005; Rohner, 2002; Yiend & Mathews, 2001). This vigilant avoidant pattern is thought to contribute to the maintenance of anxiety as it prevents the individual from habituating to the fear or anxiety provoking stimuli (Mogg, Bradley, Miles, & Dixon, 2004).

Behavioural observations of BI children show that they commonly use avoidant coping strategies to reduce their fear or anxiety. For instance, they frequently steer clear of challenging situations and shy away from meeting new individuals. This suggests that they may also use avoidant strategies when processing information.

The possibility that BI children show a vigilant avoidant pattern of attentional bias related to threat is assessed in this study using the Dot Probe paradigm with emotional face stimuli being presented for two different durations. BI children's initial attention allocation was measured by assessing attentional bias at 500 ms. Some have argued that 500 ms is too long an interval at which to assess initial automatic attention biases because several shifts of attention would be possible by this time (Koster, Verschuere, Crombez, & Van Damme, 2005), however, other research suggests this is not a concern. Specifically, two studies conducted by Bradley, Mogg, and Miller (2000) and Calvo and Avero (2005) measured eye gaze to threatening and neutral pictures, and their findings showed that generally participants did not shift their gaze prior to the 500 ms interval. However, even if the participants' eye position remains fixed, covert shifts in attention are still possible. The study by Bradley, Mogg, and Miller (2000) addressed this concern by looking at reaction times on the Dot Probe task at 500 ms, in addition to eye movements. They found that most individuals did not make frequent shifts in their gaze, but for those participants who did, there was a significant concordance between their results according to eye movement and reaction time measures. Therefore, Bradley and colleagues (2000) concluded that there do not appear to be shifts in gaze direction or covert attention on the Dot Probe task prior to 500 ms, and that it seems to be a valid measure of initial orienting. For the present study, the main advantage of using the 500 ms interval is that it is the most commonly used duration of attentional bias with the Dot Probe, therefore making comparisons with other studies easier.

To assess whether an initial preference for threat is followed by avoidance of the threatening stimuli, BI children's attentional allocation was also measured at 2000 ms. The anxiety research that has found evidence for avoidance, suggests that it occurs at or before stimuli have been presented for 2000 ms (Calvo & Pedro, 2005; Koster, Verschuere, Crombez, & Damme, 2005; Rohner, 2002; Yiend & Mathews, 2001).

BI and Response to Novel Events

As mentioned, in addition to being sensitive to threat, the other core component of BI is fear of the unfamiliar, which has received surprisingly little attention from an information processing perspective. This is an important oversight given that avoidance of novel experiences and events is a central characteristic of BI. For instance, we know that, similar to individuals with anxiety disorders, inhibited children are highly sensitive and avoidant of unfamiliar people and situations whether they seem objectively threatening or not (Cottraux, 2005). Admittedly the effects of novelty and threat may be somewhat confounded. For instance, it could be argued that novelty is perceived as threatening because it precipitates over-arousal in BI children, and/or threatening stimuli are also less familiar than neutral stimuli as threat is less commonly encountered in our environment. It is possible that these two factors have a synergistic effect in terms of eliciting negative reactions from BI children.

This study aims to provide a first step in the area by incorporating unfamiliar and familiar stimuli into the Dot Probe task to assess whether there is any evidence that BI children process unfamiliar information differently from uninhibited children, and whether the relative novelty of a threatening or neutral face influences responses to these emotional expressions. Swartz and colleagues (2003) provide suggestive evidence for the expectation that BI children would have a differential response to the novel stimuli. They looked at functional magnetic resonance imaging (*f*MRI) scans of groups of adults who had either been classified as BI or uninhibited as toddlers while they viewed novel and familiar faces. The findings revealed that the BI group showed greater amygdalar response to the novel versus familiar stimuli compared to the uninhibited group (Schwartz, Wright, Shin, Kagan, & Rauch, 2003).

STUDY 1

Goals and Hypotheses

This study examined the attentional processes of high BI children, looking at response to both threat and novelty using the Dot Probe paradigm. BI was measured using questionnaires assessing current levels of inhibition. Therefore, when children are described as high or low BI, this refers to current self or other rated BI. Attentional biases were assessed using the Dot Probe task with novel and familiar faces expressing threatening and neutral emotions. For the purposes of this experiment, stimuli are defined as novel/unfamiliar versus familiar based on the participants' total exposure time to the faces. Specifically, participants were asked to memorize a sub-set of pictures that later appeared in the Dot Probe task, amongst pictures that they did not have previous exposure to. To be clear, attention bias in this context refers to preferential processing of one stimulus (e.g. threatening faces) over another (e.g. neutral faces). The possibility that initial attentional bias for threat is followed by avoidance in BI individuals was assessed at 500 ms and 2000 ms. The hypotheses of this study were as follows:

1. High BI children will show preferential attention for threat cues
2. This bias will be heightened when stimuli are both threatening and unfamiliar
3. Initial vigilance for threat may be followed by avoidance in high BI children
4. High BI children will show a differential response to novel versus familiar faces regardless of emotional expression

Method

Participants

Forty-two children (23 males and 19 females) attending an educational summer day camp program in a university setting volunteered to participate in the study. All participants were between 8 and 14 years of age (*M* = 10.20, *SD* = 3.33). The participant sample was ethnically diverse and representative of the surrounding area. Demographic data gathered the previous year at the summer camp that the participants attended indicated that approximately 50% of the children enrolled were born in Canada, 42% were born in Asia, and the remaining 8% were born in various countries across the globe. It is assumed that roughly equivalent demographic characteristics apply to this sample, as the summer camp services similar clientele from summer to summer. Consent for participation was obtained from the campers' parents, and assent for participation was obtained from the children. Three children who were rated by their camp counsellors as having difficulty understanding or communicating in English were excluded from the study.

Materials

Behavioural Inhibition Scales

Behavioral Inhibition Instrument (BII) - self and other report (Muris, Merckelbach, Wessel, & van de Ven, 1999). The BII was developed as a potential alternative to laboratory observation of BI. The BII has two parts. The first part is the Behavioural Inhibition Scale (BIS). The BIS consists of four questions concerning the social features of BI. Specifically, the BIS asks participants about their level of shyness, fearfulness, smiling, and ease of communication. For example, one item reads, " I am shy when I have to talk to an unfamiliar person". Answers are given on a four point Likert scale which asks participants to rate how frequently each of the statements describes them with 1= never, 2 = sometimes, 3 = often, and 4 = always. The second part of the BII provides children with descriptions of low, medium, and high BI and asks them to place themselves in a category. The entire BII is included in Appendix A.

The children's camp counsellors were given a modified version of the second part of the BII - Other report, which consisted of the same descriptions of the three categories of BI. This modified version of the BII is included in Appendix B. Counsellors were instructed to place each of the children into one of the categories. This measure was included in order to get a rating that was based on observation of the children's behaviour in a novel social situation (e.g., the summer camp program).

The BII and its modifications have been administered to children and adolescents aged 11 through 18 (Muris, Merckelbach, Wessel, & van de Ven, 1999; Muris, Merckelbach, Schmidt, Gadet, & Bogie, 2001, Muris, Meesters, & Spinder, 2003). It was found to have satisfactory internal consistency (alpha = 0.72 – 0.82) (Muris, Merckelbach, Wessel, & van de Ven, 1999; Muris, Merckelbach, Schmidt, Gadet, & Bogie, 2001). The extent to which the BII self-report form is related to laboratory observations of BI has not yet been examined. Related research, however, provides suggestive evidence that ratings obtained from these two methods would be correlated. For instance, the modified parent form of the BIS was found to be significantly related to ratings of BI based on observation (van Brakel, Muris, & Bogels, 2004). Further, BIS scores and observational ratings of BI show similar patterns of relationships to various anxiety symptoms (Muris, Merckelbach, Wessel, & van de Ven, 1999; Muris, Merckelbach, Schmidt, Gadet, & Bogie, 2001).

Modified Behavioral Inhibition Questionnaire (BIQ: Bishop, Spence, & McDonald, 2003). The BIQ was developed as a parent and teacher report of behavioural inhibition in young children. The item content assesses both the social and non-social aspects of BI. In this study it was modified into a self-report measure for older children. One of the original items (Happily separates from parent(s) when left in new situations for the first time, e.g., kindergarten, preschool, childcare), was omitted because it was not appropriate for the sample age group, Thus, 29 of the original 30 items were reworded into as self report statements. For example, "Approaches new situations or activities very hesitantly" was changed to "I approach new situations or activities very hesitantly", "Enjoys being the centre of attention" was changed to "I enjoy being the centre of attention". The modified BIQ is included in Appendix C.

Preliminary research conducted on the psychometric properties and validity of the BIQ parent and teacher forms supports the utility of the test. A factor analysis of the parent and teacher versions of the BIQ revealed that the test measures 6 correlated factors reflecting reactions to unfamiliar adults, peers, separation, performances, novel situations, and physical activities with slight risk of injury (Bishop, Spence, & McDonald, 2003). The parent and teacher versions were found to have satisfactory internal consistency, and the parent version had acceptable stability over a yearlong period. The BIQ parent and teacher forms were significantly correlated with the inhibition subscale of the child temperament questionnaire, providing evidence of concurrent validity. Further, the children's BIQ scores were also significantly related to ratings of BI based on observation, providing support for the scale's construct validity (Bishop, Spence, & McDonald, 2003). Whether similar findings would be obtained when the BIQ is used as a self-report measure needs to be assessed in future research.

Experimental Tasks

Given that this study aims to assess the effect of familiar versus unfamiliar information on information processing, a memory game was designed to familiarize participants with a subset of the pictorial face stimuli to be presented in the Dot Probe task. The details of this task are described below.

Face stimuli memory game. Four faces (2 male and 2 female) from the Pictures of Facial Affect that were developed by Ekman and Freisen (1975) were used in the memory game. The faces later made up the familiar stimuli in the Dot Probe task. Pictures of each stimuli face displaying neutral, happy, and angry emotions (for a total of 12 pictures) were displayed in a randomly arranged 3 x 4 grid on an 8.5 x 11 inch paper. This pictorial grid was provided to each child and placed face down in front of them. The participants were also given an empty 3 x 4 grid of identical size. The experimenter had individual pictures of each of the faces on the grid displaying all three affects on separate, 8.5 x 11 inch sheets of paper. These were placed face down in front of the experimenter.

The experimenter explained to the participants that they would be playing a memory game with faces and that they were going to be asked to try to remember as many pictures as they could. Verbatim instructions for the memory game provided by the experimenter were as follows:

> When I say "go" you can turn over the sheet with all the faces on it. You will have 20 seconds to look at it and try to memorize all the faces and where they are on the grid. Then when I say to "turn it over" you need to quickly put the sheet face down in front of you. We will then turn over the other sheet with the blank grid and I'll pick out one of the pictures that was on the grid with the faces and ask you where you think it was. We'll keep doing that until I've asked you about each of the faces.

The experimenter then answered any questions and elaborated on the instructions as necessary. The children were instructed to turn over the sheet with the faces and to "Remember to closely look at all the faces and try to memorize them as best you can." The examiner did not give this prompt at the beginning of every trial, although encouragement was provided as appropriate to maintain engagement in the task. The examiner monitored the exposure times with a stopwatch. The stimuli grids were presented for 25 seconds (s) for the first four trials, 20 s for the middle 4 trials, and 15 s for the last 4 trials. The exposure time was reduced across trials as an attempt to minimize boredom because the children became more familiar with the faces throughout the course of the game. At the end of each trial, the experimenter ensured that the children turned their sheets with the pictures face down, and then turned their sheets with the blank grid face up. The experimenter then held up one of the faces they were instructed to memorize for 5 s. The children were told to mark down where they believed that the face was on the empty grid. This was repeated until the experimenter had shown each of the 12 pictures.

Pictorial Dot Probe task (MacLeod, Mathews, & Tata, 1986). MacLeod, Mathews, and Tata (1986) created the Dot Probe task to assess attention bias towards different words (e.g. threatening and non threatening) in adults. However, using word stimuli with children could be problematic because their reading ability and reading speed would interfere with their attentional bias ratings (Vasey, 1996), therefore, this study used facial stimuli. Some evidence also suggests that the dot probe task with facial stimuli is a more sensitive measure of attentional bias (Pishyar, Harris, & Menzies, 2004).

Facial Stimuli and Trials. Face stimuli for the Dot Probe task were taken from the Pictures of Facial Affect that were developed by Ekman and Freisen (1975). The stimuli consisted of the 2 female and 2 male faces used in the memory game (henceforth referred to as "familiar faces"), and 6 female and 4 male faces that were presented for the first time during the Dot-Probe task (unfamiliar faces). An unequal number of novel males and females were used because 2 additional male faces were unavailable and the maximum number of stimuli were needed for the task. Each trial consisted of two 84 X 126 pixel pictures of the same person with two different facial expressions, one angry and one neutral. Pictures were presented beside each other with a 132 pixel separation between them at mid screen. The angry and neutral faces were positioned an equal number of times on the left and right sides of the screen. In half the trials, the stimuli were presented for 500 ms and in the other half they were presented for 2000 ms. The 4 familiar face pairs were presented in 8 practice trials, and 5 times during the course of the experiment. The 10 novel face pairs were presented twice during the experiment. Therefore, the unfamiliar faces had a total exposure time of 2.5 s (2500 ms) (each face is shown once at the 2000 ms interval and once at the 500 ms interval during the experiment). Familiar faces had a total exposure time of roughly 253 s (253000 ms) to 255 s (254500 ms) (this cannot be precisely measured for each individual face due to the nature of the memory game). In sum, there were 40 experimental trials (20 novel and 20 familiar), each showing a familiar or novel individual displaying angry and neutral affects. The order in which the different faces and expressions were presented was randomised across individuals.

Task Procedure. Between 9 to 12 children came into a computer-equipped classroom at Simon Fraser University to participate in the study at any one time. The room had several tables with chairs arranged in an oval in the middle of the room, and computer workstations arranged around the perimeter of the classroom. Participants initially sat at the tables and were given a brief verbal introduction to the task which summarized the full instructions outlined below. Then each child was given their own computer workstation and they were seated approximately 75 cm from their computer screens. The workstations were oriented so that the children sat with their backs to the centre of the room. Full instructions for the Dot Probe task were presented on each computer. The screen read:

> Welcome to the experiment! First, you will see a + on the screen. Then, you will see 2 faces. After the faces, you will see a *. It will be on either the right or the left side of the screen. If the * is on the left, press the left arrow (marked by a green dot). If the * is on the right, press the right arrow (marked by a yellow dot). Do this as quickly and accurately as you can. If you make a mistake, just keep going. Press any key to begin! First, we'll do some practice trials... Remember, press left arrow (green dot) if the * is on the left or right arrow (yellow dot) if the * is on the right. Press any key to begin!

The instructions were followed by the 8 practice trials, during which the experimenters walked around the lab and briefly checked that the children understood the task. Another reminder concerning the instructions for the task was then presented on the screen, followed by the 40 experimental trials. The stimuli appeared on the screen in random order. Each trial in the study began with a central fixation cross that was presented for 500 ms. Immediately following this, the pair of faces was presented (for either 500 ms or 2000 ms). A probe then appeared in the location of one of faces. An example of the stimuli used is provided in Appendix D. When children detected the probe they were to press either the right or left arrow key (marked with yellow and green dots respectively) on a computer keyboard to indicate where they had seen it. The probe remained on the screen until either a response had been made or 5 s (5000 ms) had passed. The latency to detect the probes was measured, and this is taken to reflect the degree of attention to the face that appeared prior to the presentation of the probe.

Procedure

The experiment was run during one term of an educational summer day camp. The camp had psychology classes and the experimenter attended one of these sessions to administer the facial stimuli memory game. After the memory game, the experimenter shared some facts about memory with the children and answered any questions they had.

Two days later, during another psychology class, the children came to a computer lab to participate in the experiment. The experimenter first gave a brief introduction to research and experiments in the field of psychology. The children then filled out the BIS and BIQ with the experimenter. The instructions and questions on the questionnaires were read out loud to the children, and the experimenter answered any questions concerning word definitions as briefly and accurately as possible. This was done to ensure that all children fully understood the questions and descriptions on the measures. This was considered important because the BIS and BIQ have not been administered to children ages 8-12 before, therefore the reading level of the questionnaires was a concern. The camp counsellors filled out the BIS-Other report form during this time.

When the children had completed the questionnaires, they were each assigned to a computer where they completed the Pictorial Dot Probe task, as described above. Once all of the participants had completed the task, they were told about the hypotheses of the study and the possible relevance of the findings and the experimenter answered any questions. Each child was given a small prize and thanked for their participation.

Results

Participants

Three of 45 children who volunteered to participate were rated by their camp counsellors as having difficulty understanding or communicating in English, and were excluded from the study. Of the remaining 42 participants, 5 were identified as speaking English as their second language. In order to check whether all the participants understood the tasks, each child's questionnaires were checked for inconsistent responding (questionnaire responses were deemed invalid if more than 2 contradictory answers were endorsed on the BIS or more than 3 contradictory answers were endorsed on the BIQ), and their number of inaccurate responses on the Dot Probe task was examined (subjects were excluded if they made inaccurate responses on the Dot Probe task more than 25% of the time). This resulted in the exclusion of two participants who had unacceptably high levels of inaccurate responses (inaccurate trials > 68%; for all remaining participants inaccurate trials < 10%) on the Dot Probe task. The rest of the analyses were conducted using the remaining 40 participants (21 males and 19 females).

Relationships between Measures

In order to examine the correspondence between the counsellors' ratings and the participants' self-ratings of BI, Intraclass Correlations were performed. As described above, part 2 of the BII asked counsellors and children to place the children into one of three categories describing low, mid, and high BI. Counsellor and self-report classifications of BI (based on part 2 of the BII) were not significantly related to each other. In fact in some cases the two yielded opposite classifications, (ICC = -.102, p = .731). There is no previous empirical evidence or theoretical reason that would lead us to expect that self-ratings and other ratings of BI would be uncorrelated or negatively related. Muris, Meesters, and Spinder (2003) found that self-ratings and parent ratings on part 2 of the BII were significantly positively correlated (r = .42). It is important to note, however, that at the time of the experiment, children had only been with the counsellors for 8 days. The non-significant negative relationship between self and counsellor ratings suggests that counsellors had not had enough time to get to know each individual child well enough to make accurate ratings. In light of this concern, the children's self-ratings rather than counsellor ratings were used to classify the children into the high and low BI groups.

The children completed two self-report questionnaires, the BIS and the BIQ. The BIS scores in this sample ranged from 5 to 16, with 10.5 as the median value (*SD* = 2.95). The BIQ scores ranged from 42 to 166 with 108 as the median value (*SD* = 26.64). Using a Pearson correlation the participants' self reported BI on the BIS and BIQ was significantly related $r(40) = 0.55$, $p = .001$. Some variation in scores on these two measures was expected because the version of the BIS that was administered only assesses the social aspects of BI, whereas the BIQ assesses BI in social, situational, and physical situations. Therefore, the correlations obtained between the BIQ and BIS were judged to be satisfactory.

Questionnaire Standardization and Combination

The BIS and BIQ were standardized on 228 children who attended the camps across two seasons. All participants in the standardization sample were between ages 7-14, and there were an approximately equal number of males (48%) and females (52%). Each participant's raw scores on the BIS and on the BIQ were converted into *z* scores, and then the *z* scores were converted into T scores. The participant's T scores on the BIS and on the BIQ were combined and then divided by 2, yielding a total BI T score. In this way both the questionnaires received an equal weighting [1].

1 The questionnaire standardization was not completed until one year after this study was run. Initially the BIS and BIQ were combined by summing the participants' rank order on each questionnaire, yielding an overall rank score. The participants were then divided into low and high BI groups based on a median split of their overall rank scores. This method of dividing the groups is inferior to using combined T scores because using T scores converts the results of both questionnaires onto identical scales and ensures that both questionnaires receive equal weighting. Therefore, once the standardization was complete, the groups were re-defined using combined T scores and the subsequent analyses were re-run. The significant findings were the same regardless of whether the groups were formed using combined ranks or T scores.

Group Characteristics

The children were divided into low and high BI groups based on a median split of the BI total T scores. The boundary dividing the two groups was T = 48. The low BI group consisted of 10 males and 10 females and the high BI group consisted of 11 males and 9 females. The two groups differed significantly in their self endorsed BI, $t(38) = -7.71$, $p < .001$. The low and high BI groups mean age and total BI T scores are found in Table 1.

Table 1:

Mean Age and BI Total T Score as a Function of BI Group.

		Age		BI T score	
BI Group	*N*	*M*	*SD*	*M*	*SD*
High	20	10.05	3.82	54.38	6.15
Low	20	10.40	2.93	39.81	6.08

Preparation of the Reaction Time Data

As noted above, two subjects were eliminated from the analyses due to unacceptably high levels of inaccurate responding (inaccurate trials > 68%). For the remaining 40 participants, the trials with errors were discarded, which eliminated 3.84% of the data. To minimize the influence of extreme outliers, all reaction times of less than 100 ms and greater then 3000 ms were removed. Each participant's data was also examined for outliers using box-and-whisker plots, and reaction times greater than 3 *SD* from the participant's mean were removed. In total, 2.20% of the data was identified as extreme outliers and discarded.

Face Stimuli Characteristics: Gender Effects

A 2 x 2 Mixed Design ANOVA, with participant gender as the between subjects variable and face stimuli gender as the within subjects variable, was performed to assess whether the gender of the face stimuli affected participant responses on the Dot Probe task. The gender of the face stimuli was not significantly related to reaction times, $F(1, 38) = 0.18$, $p = .67$, and the gender of the face stimuli did not significantly interact with the gender of the participant, $F(1, 38) = 0.00$, $p = .99$.

Participant Gender and Age Analyses

Potential gender differences in self reported BI were examined using a *t* test. Males and females were not found to vary in BI total T scores, $t(38) = .13$, $p = .90$. Males' and females' Dot Probe performance was also compared using an ANOVA with gender as the between subjects variable, and reaction times based on face familiarity (novel vs. familiar), emotional expression (threatening vs. neutral), and duration of stimulus presentation (500 ms vs. 2000 ms) as the dependent variables. Gender was not significantly related to overall reaction time, $F(1, 39) = .16$, $p = .70$. Gender also did not significantly interact with attentional bias, $F(1, 39) = .03$, $p = .86$, response to face familiarity, $F(1, 39) = < .001$, $p = .98$, or duration of stimulus presentation, $F(1, 39) = .72$, $p = .40$. Given that the participants' gender did not influence any of the dependent variables, it will not be considered in the subsequent analyses.

Potential differences attributable to the participants' age were examined using a series of Bivariate Pearson correlations. To assess whether age was related to attentional bias, attentional bias scores were calculated for each participant by subtracting their reaction times when the probe followed a threatening face from their reaction times when the probe followed a neutral face. Therefore, positive values would suggest an attentional bias towards threat. Participants' age did not influence attention bias scores, $r(40) = -.06$, $p = .73$, or differences in responses to novel versus familiar face pairs, $r(40) = -.04$, $p = .82$. Similarly, age was not significantly related to BI, $r(40) = .09$, $p = .58$. However, age was significantly negatively related to average overall reaction time, $r(40) = -.33$, $p = .04$. Therefore, age is not significantly related to the dependent variables of interest, however, it adds variability to reaction times on the Dot Probe task. In order to look at the effects of BI on reaction times over and above age, age will be treated as a covariate in the ANCOVA analyses.

Response to Threat and Novelty

High and low BI children's reaction time means and standard deviations for all Dot Probe conditions are presented in Table 2.

Table 2:

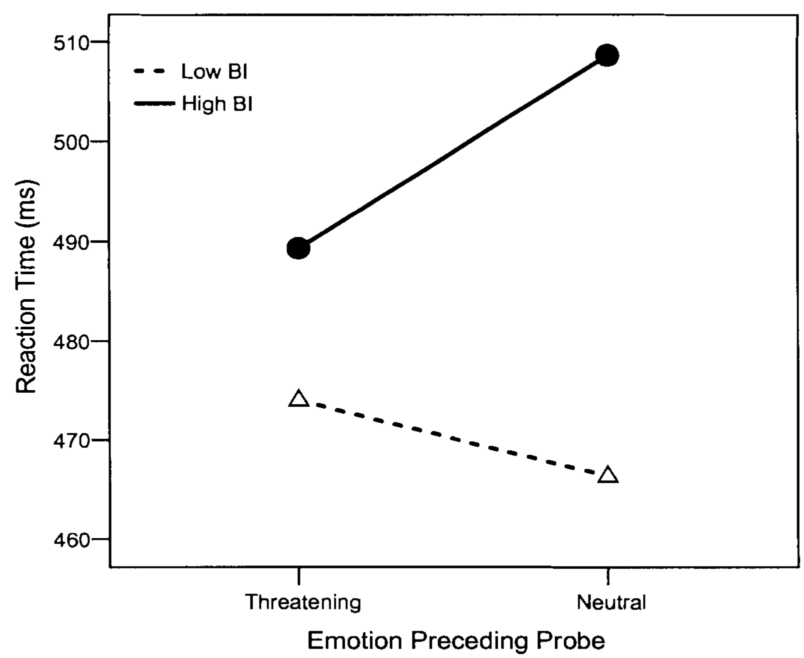
Mean of Participants' Median Reaction Times (ms) as a Function of BI Group, Threat, Stimulus Duration, and Face Familiarity.

	Group			
	High BI (*n* = 20)		Low BI (*n* = 20)	
Condition	*M*	*SD*	*M*	*SD*
Emotion Preceding Probe				
Threatening	489.30	100.49	473.93	100.24
Neutral	508.65	138.53	466.31	87.76
Stimulus Duration				
500 ms	509.72	132.24	488.61	112.57
2000 ms	488.23	112.57	451.63	75.18
Face Stimuli				
Unfamiliar	493.31	106.68	475.77	103.83
Familiar	504.64	132.34	464.47	84.36

Median reaction times were calculated for each subject and condition and entered into a 2 x 2 x 2 x 2 Mixed Design ANCOVA. There was one between subjects variable of BI (high vs. low) and three within subjects variables of face familiarity (novel vs. familiar), emotional expression (threatening vs. neutral), and duration of stimulus presentation (500 ms vs. 2000 ms). As mentioned, age was entered as a covariate. No significant main effects were found. As hypothesized, the interaction between BI and threat was significant, $F(1, 37) = 4.01$, $p = .05$, indicating that high and low BI children are differentially affected by threatening stimuli. An examination of the plot of this interaction shows that high BI children responded faster to probes preceded by threatening faces compared to probes preceded by neutral faces, whereas low BI children showed the opposite tendency with a smaller reaction time difference. See Figure 1 for a plot of this interaction.

Figure 1:

Graph illustrating the significant interaction between BI and response to probes following threatening or neutral faces.

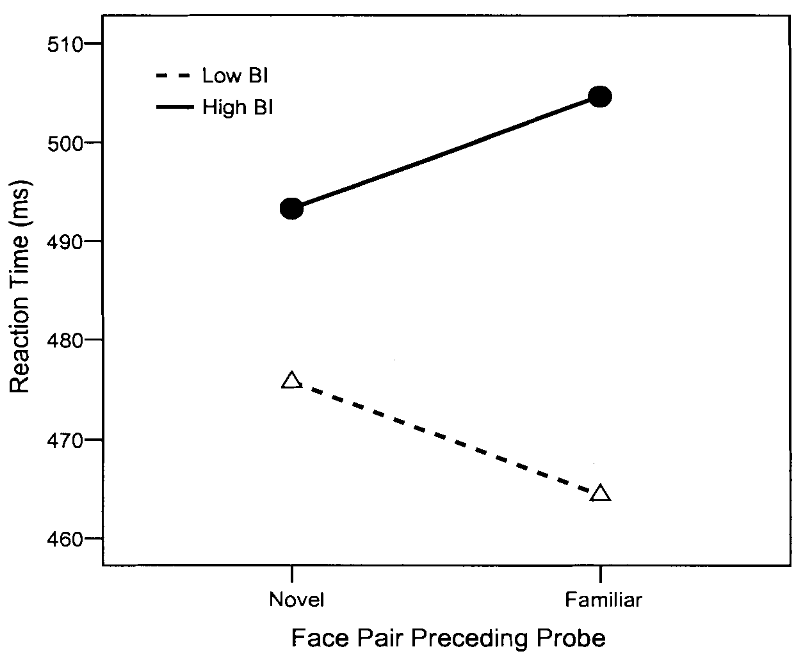


However, when paired samples t-tests were conducted separately for the BI groups, the differences in reaction times for probes following threatening versus neutral faces were not significant within the high BI, $t(19) = 1.57$, $p = .13$, or low BI, $t(19) = .10$, $p = .92$ groups.

The interaction between BI and face novelty was also significant, $F(1, 37) = 4.48$, $p = .04$, indicating that high and low BI children respond differently to unfamiliar faces. The plot of this interaction shows that high BI children responded faster to novel faces than to familiar faces, and low BI children conversely responded faster to familiar than novel faces. See Figure 2.

Figure 2:

Graph illustrating the significant interaction between BI and response to probes following novel or familiar face pairs across trials.



The difference in reaction times to probes following novel versus familiar face pairs using paired samples *t* tests was not significant within the high BI, $t(19) = 1.49$, $p = .15$ group but there was a trend for the low BI group to respond faster to the familiar faces, $t(19) = -1.86$, $p = .08$.

The interaction between BI, response to threat, and stimulus duration was not significant, $F(1, 37) = .01$, $p = .91$.

Discussion

While the differences in responses to threatening versus neutral faces were not significant within BI groups, the results of Study 1 indicate that children with high self rated BI are more likely to attend to threatening facial expressions than children with low self rated BI. These findings are consistent with Mathews and MacLeod's (2002) findings that attentional biases have causal effects on vulnerability to anxiety. Additionally, they add to our understanding of the potential mechanisms underlying the relationship between BI and anxiety disorders. As discussed, children with higher levels of BI are more easily distressed and aroused in response to minor challenges, threats, and novel situations. The results of Study 1 suggest that they have a greater tendency to focus on the threatening aspects of their social environment, which is likely to trigger and maintain heightened arousal, feelings of anxiety, and exaggerated beliefs about the dangers in their surroundings. Focusing on potential cues to threat may also exacerbate anxiety by allocating processing resources that may otherwise be available to engage in more constructive coping.

There was no evidence that this initial focus on threat is followed by avoidance of the threatening stimuli. The absence of avoidance could be related to the fact that the participants in this study were children so their strategic control of attention is still developing. This explanation seems unlikely, however, because age was not related to attentional biases at either stimulus duration interval. Therefore, at least over the stimulus durations used in this study (500 ms and 2000 ms), it did not appear that BI children attempted to regulate their emotional experience using attentional avoidance of threat.

The pattern of high and low BI children's attentional biases for threat was the same whether the face pairs presented were novel or familiar. However, as predicted, the high and low BI groups responded significantly differently to stimuli that were novel across trials. While, again the differences within the groups were not significant, high BI children responded faster to the unfamiliar stimuli across trials, whereas the low BI group showed the opposite pattern with faster reaction times to the familiar face pairs. These results could be interpreted in several ways. The low BI group's faster responses to probes following familiar face pairs could be taken as evidence of habituation. Specifically, processing faces that have been repeatedly previously viewed may take up less cognitive resources so participants have more resources available to prepare for the subsequent probes and respond to them as soon as they appear. Conversely, processing faces that are unfamiliar may take up more cognitive resources that would not immediately become available the moment the face pairs disappear, which results in a lag in responding to the subsequent probes. However, the high BI group's results do not fit with this explanation showing no evidence of habituation to familiar faces. High BI children's responses were faster to unfamiliar stimuli, which seemed to increase their alertness or readiness to respond. This finding may suggest that unfamiliar stimuli are particularly salient for BI children from an information processing perspective. Future research is needed to clarify these findings.

This is the first time response to novelty has been explored in an information-processing task with high BI individuals, and these findings indicate that this is an important area to follow up in future research. In particular, it would be valuable to assess if BI children would also have faster responses to novelty if novel stimuli were pitted against familiar stimuli, so that they had to compete for attentional resources. If novel stimuli are particularly salient for BI individuals, it would be expected that they would show an attentional preference for novelty, similar to what was found for threat. It could be that BI children process threat and novelty in a similar way, and that vigilance for unknown stimuli is also associated with vulnerability for anxiety. Certainly, it is clear that for BI children, as well as social phobics, both novelty and threat are capable of eliciting similar behavioural responses (Cottraux, 2005).

This study is not without limitations. The sample size was relatively small. As only 40 children participated in the study, statistical power to detect effects was somewhat low, and BI groups were formed using a median split in order to ensure there were enough participants per group. Although, median splits are popularly used in research (e.g. Mogg, Bradley, de Bono, & Painter, 1997; Mogg et al., 2000; Rohner, 2002) it is not an ideal method for dividing groups. While there are generally significant differences between the groups formed, the participants close to the median do not truly differ from each other. This results in reduced sensitivity to detect differences associated with the grouping variable. In the present study, the small sample size and use of a median split may account for the insignificant within group findings, as several of the reaction time differences were quite large. For instance, Yiend and Mathews

(2005) reported that in past research the differences in reaction times to threatening versus neutral stimuli are generally 10 ms to 20 ms, and in this study the high BI group responded 19.24 ms faster to threatening faces than neutral faces. A further limitation related to the small sample size is that children who are at the extremes of low and high BI may have different attentional biases related to threat and novelty for different reasons, compared to average children. It would be useful to assess how high BI children differ from mid BI children as well as low BI children.

Another potential limitation concerns the measures of BI that were used. Specifically, this appears to be the first time that the BIQ has been used in self-report form. Preliminary research on the parent and teacher forms of the BIQ demonstrated adequate psychometric properties (Bishop, Spence, & McDonald, 2003), but it cannot be assumed that this would apply to the self-report form.

STUDY 2

Understanding the mechanisms underlying the link between temperament and anxiety has important theoretical and clinical implications. An attentional bias for cues to threat, which has been found in anxious populations, has been identified as a potential mediator in this relationship. Study 1 provided evidence suggesting that BI children may exhibit information processing biases related to threat and novelty, however a second study would be useful to clarify these findings. Study 2 was designed to address the identified limitations of Study 1 and to further explore potential biases related to novelty.

Study 1 showed that high BI children had a greater tendency to focus on threat than low BI children, but contrary to what was expected, the within group differences were not significant. However, as discussed, it seems that the small sample size used in Study 1 may have limited the ability to detect significant effects. To explore this possibility, Study 2 aimed to replicate Study 1 with a larger sample.

The increased sample size also allowed the selection of extreme low and high BI groups, as well as a mid BI group. The selection of extreme groups (as opposed to groups based on a median split) ensures that all the individuals in the low and high BI groups truly differ from each other in terms of BI, and maximizes the ability to detect between group differences. It also allows for comparisons between individuals at both extremes of BI and whether they differ in information processing from children in the average range.

Study 2 was also designed to further explore whether high, low, and mid BI children's responses differ to novel stimuli. The results of Study 1 showed that novel stimuli seem to increase high BI children's readiness to respond. Therefore, it may be that novel stimuli are especially salient for high BI children. To test whether high BI children show an attentional bias to unfamiliar stimuli, as well as threat, trials were added to the Dot Probe task where novel and familiar stimuli were pitted against each other.

Finally, as a first step to assessing the psychometric properties of the modified self-report version of the BIQ used in Study 1, the parent form of the BIQ was administered in addition to the self-report BIQ form to assess their agreement.

To summarize the hypotheses of this study were as follows:

1. High BI children will show preferential attention for threat cues
2. High BI children will show a faster response to novel versus familiar faces across trials regardless of emotional expression
3. High BI children will show preferential attention for novel stimuli

Method

Participants

Two hundred and eleven children attending the same educational summer day camp program as in Study 1 but in the following year volunteered to participate in this study. All participants were between 7 and 14 years of age. The participant sample was ethnically diverse and representative of the surrounding area. Demographic data gathered the previous years at the summer camp that the participants attended indicated that approximately 50% of the children enrolled were born in Canada, 42% were born in

Asia, and the remaining 8% were born in various countries across the globe. There is no reason to believe that similar demographic characteristics would not apply to this sample. Consent for participation was obtained from the campers' parents, and assent for participation was obtained from the children.

Materials

Behavioural Inhibition Scales

The *Behavioral Inhibition Instrument – Parent and Self Report Forms* (Muris, Merckelbach, Wessel, & van de Ven, 1999) and the *Behavioral Inhibition Questionnaire-Parent and Self Report Forms* (Bishop, Spence, & McDonald, 2003) were administered. See Study 1 for a description of these measures. The BII parent form is provided in Appendix E, and the BIQ parent form is provided in Appendix F.

Experimental Tasks

Face stimuli memory game. In this study two sets of faces were combined: the Pictures of Facial Affect developed by Ekman and Freisen (1975) and the emotional face set developed by Niedenthal (e.g. Halberstadt, Niedenthal, 1997; Niedenthal, Halberstadt, Margolin, & Innes-Ker, 2000). Stimuli were drawn from these two sources to provide a larger stimuli set than that used in Study 1. As in Study 1, participants were administered a memory game in order to familiarize them with a subset of the pictures to be used in the Pictorial Dot Probe task. The pictures used in this memory game included one female and one male from the Ekman and Freisen (1975) picture set, and one female and one male from the Niedenthal (2000) picture set. These four individuals each displaying neutral, happy, and angry faces were displayed on a randomly arranged

3 x 4 grid on an 8.5 x 11 inch piece of paper. The grid was presented face down to each of the children. The participants were also given an identical empty 3 x 4 grid. The experimenter had individual pictures of each of the faces on the grid displaying all three emotions on separate, 8.5 x 11 inch sheets of paper. These were placed face down in front of the experimenter. The instructions and procedure for the memory game were the same as those described in Study 1.

Pictorial Dot Probe task (MacLeod, Mathews, & Tata, 1986). The Dot Probe task was again administered with the following modifications: facial stimuli were used, and a direct test of attention allocation to threat (angry vs. neutral faces) and to novelty (familiar vs. unfamiliar faces) was included.

Facial Stimuli and Trials. The stimuli faces used were taken from the Pictures of Facial Affect developed by Ekman and Freisen (1975) and the emotional face set developed by Niedenthal (e.g. Halberstadt, Niedenthal, 1997; Niedenthal, Halberstadt, Margolin, & Innes-Ker, 2000). The stimuli consisted of the 4 familiar pictures used in the memory game, as well as 12 novel faces (7 female and 5 male) from the Ekman and Freisen (1975) face set and 16 novel faces (8 female and 8 male) from the Niedenthal (2000) face set. The decision to include an unequal number novel female and male face stimuli was made to maximize the stimuli available. As in Study 1, the display size for each picture was 84 x 126 pixels, and 2 pictures were presented in each trial, on the right and left sides of the screen with 132 pixels between them. This task differed from the task in Study 1 in that in all trials the face stimuli were presented for 500 ms. The additional 2000 ms interval used in Study 1 was not included in Study 2 because there was no evidence for shifts in attention at this longer interval in Study 1. Also, Study 2 had a larger number of trials than Study 1 and only using the shorter stimulus duration of

500 ms helped to keep the task short to reduce the likelihood that children will become bored and inattentive. In Study 2 the familiar faces were presented 4 times during the practice trials, and 12 to 15 times during the course of the experiment. The unfamiliar faces were presented twice during the course of the experiment. Therefore, in total, unfamiliar faces had 1 s (1000 ms) of exposure time, compared to roughly 253 s (253000 ms) to 255 s (254500 ms) for the familiar faces (again this cannot be precisely measured for each individual face due to the nature of the memory game).

The task in Study 2 involved two types of trials. One set of trials followed the same format as the trials in Study 1, which provided a direct test of attentional biases related to threatening faces. As in the previous task, each trial showed the same person with two different facial expressions, angry and neutral. The angry and neutral faces appeared an equal number of times on the left and right sides of the screen. The 28 unfamiliar faces were each presented once, and the 4 familiar faces were presented 7 times in this format.

The additional set of trials in this experiment was added to provide a direct test of attentional biases related to novel faces. In these trials, pictures of two different people, one novel and one familiar, were presented on the left and right sides of the screen. Novel and familiar people appeared on the left and right sides of the screen an equal number of times. The novel individuals were always matched with a familiar individual from the same facial stimuli set (Ekman and Freisen or Niedenthal), gender, and emotional expression. In half of the trials, both individuals had an angry facial expression and in the other half of the trials they both had a neutral facial expression. All the unfamiliar faces appeared once each in this form of trial, and the familiar faces appeared once for every novel face of the same gender and facial set (i.e. the familiar male and female from the Niedenthal (2000) face set were repeated 8 times each, the familiar male from the Ekman and Freisen (1975) set was repeated 5 times, and the familiar female was repeated 7 times).

Therefore, there were 84 experimental trials, 56 of which provided a direct test of attentional biases related to threatening faces and 28 of which provided a direct test of attentional biases related to novel faces.

Task Procedure. Between 9 to 20 children came into a computer-equipped classroom at Simon Fraser University to participate in the study at any one time. Given that the computer lab that was used in Study 1 was no longer available, Study 2 was run in a different lab where the computers were arranged in several rows that faced the front of the classroom. Each child sat at their own computer, approximately 75 cm from their computer screen. The experimenter began by giving a brief verbal introduction to the computer task that summarized the full instructions, which then appeared on the computer screen at the outset of the task. The full computer task instructions are identical to those presented earlier in Study 1. The verbal instructions were followed by the 16 practice trials, during which the experimenters circulated amongst participating children to ensure that they understood and were correctly following the task instructions. A reminder concerning the instructions then appeared on the screen, followed by the 84 experimental trials. Both types of experimental trials appeared on the screen in random order. As in Study 1, each trial began with a central fixation cross that was presented for 500 ms. Immediately following this, a pair of faces was presented for 500 ms. Then a probe appeared in the location of one of the faces. Examples of the stimuli used for the different trials are provided in the Appendices (See Appendix D for an example of the stimuli used in a trial where threatening and neutral faces (which are either familiar or unfamiliar) are pitted against each other, see Appendix G for an example of a trial where neutral novel and familiar faces are pitted against each other, and see Appendix H for an example of a trial with angry novel and familiar faces pitted against each other). After presentation of the probe, participants pressed either the right or left arrow key (marked with yellow and green dots respectively) on the computer keyboard to indicate the probe location. The probe remained on the screen until either a response had been made or 5000 ms had passed.

Procedure

The educational camps were run in two-week sessions and this experiment was run during the final week of each session. The procedure for Study 2 was identical to that of Study 1 for the first two camp sessions. The procedure for the third session was identical to the others with the exception that children were given the BIQ – parent form and the BII – parent form to take home to their parents on the day of the memory game. The children were asked to bring back the questionnaires their parents filled out on the day the experiment was run.

Results

Participants

Camp counsellors identified 7 of 218 campers as having insufficient English language abilities to fully understand the instructions given in the study. These children were permitted to participate in the experiment with their peers, but their data was excluded before the analysis. This left 211 participants, of whom 38 were identified as speaking English as their second language. As in Study 1, to assess whether the remaining participants understood the tasks and/or were sufficiently motivated: 1) their questionnaires were checked for inconsistent or random responding (questionnaire responses were deemed invalid if more than 2 contradictory answers were endorsed on the BIS or more than 3 contradictory answers were endorsed on the BIQ), and 2) the number of inaccurate responses on the Dot Probe task were assessed (subjects were excluded if they made inaccurate responses on the dot probe task more than 25% of the time). Using the above described criteria, 15 participants were excluded from the sample due to inconsistent questionnaire responses, and another 5 were excluded due to unacceptably high levels of inaccurate responses on the Dot Probe task, leaving 191 participants. Finally, 3 participants were excluded because there was no record of their Dot Probe responses on the computer they used (this was likely due to the children pressing incorrect keys or accidentally exiting the program). Therefore, the final sample consisted of 188 participants (89 male and 99 female), ranging in age from 7 to 14 years (*M* = 10.99, *SD* = 1.69).

Measures of BI

All participants filled out 2 self-report measures, the BIS and the BIQ. BIS self-report scores in the entire sample ranged from 4 to16, with a mean value of 10.03(*SD* = 2.46). BIQ self-report scores ranged from 48 to 164, with a mean value of 107.46(*SD* = 21.73).

The third session of the experiment had 56 participants. All of the participants in this final session were given the BIS parent report form and the BIQ parent report to take home to their parents to fill out (in addition to completing the self-report forms themselves). Twenty-seven of the BIS parent forms and 29 of the BIQ parent forms were returned. Parent ratings of the participants on the BIS ranged from 4 to 16, with a mean value of 9.68(SD = 2.65). Parents rating on the BIQ ranged from 49 to 167, with a mean rating of 101.79(SD = 29.70).

Relationships between Measures

To examine the association between the two measures of BI, Pearson correlations were used. The participants' BIS and BIQ self report scores were significantly related, $r(188) = 0.63$, $p < .001$. The parent ratings on the BIS and BIQ parent report forms were also significantly related, $r(26) = .81$, $p < .001$.

Contrary to what was expected, the participants' self-ratings and their parents' ratings were not significantly correlated on either the BIS, $r(27) = .19$, $p = .34$ or the BIQ, $r(29) = .19$, $p = .32$. Further, the differences between parent and child ratings were not related to the child's age, $r(27) = .08$, $p = .70$ for the BIS and, $r(29) = -.16$, $p = .41$ for the BIQ. Finally, the magnitude of the differences between the parent and child ratings did not differ depending on the child's gender, $t(25) = -.33$, $p = .75$ for the BIS and, $t(27) = .66$, $p = .51$ for the BIQ.

Questionnaire Standardization and Combination

As mentioned in Study 1, scores on the BIS and BIQ were standardized across the combined 228 participant sample from both Study 1 and Study 2. As described in Study 1, participants' raw questionnaire scores were converted into *z* scores, and then converted into T scores. The participants' T scores on the BIS and on the BIQ were then combined and divided by 2, yielding a total BI T score.

BI Group Characteristics

Children were divided, based on their combined BI T score, into one of 3 BI groups. The low BI group included those children whose total BI T score was greater than 1 *SD* below the mean (T < 40). Conversely, the high BI group included the children whose total BI T score was greater than 1 *SD* above the mean (T > 60). The mid BI group was formed by taking the 25 participants that were within one *SD* of the mean total T BI score (48.68 < T < 51.17). The low, mid and high BI groups mean age and total BI T scores are found in Table 3.

Table 3:

Mean Age and BI Total T Score as a Function of BI Group

		Age		BI T score	
BI Group	*N*	*M*	*SD*	*M*	*SD*
High	22	10.73	1.39	64.82	3.86
Mid	25	11.44	1.66	50.04	0.78
Low	23	12.09	1.73	35.06	3.89

Preparation of the Reaction Time Data

All trials with errors were discarded which eliminated 3.2% of the data. To minimize the influence of extreme outliers, reaction times of less than 100 ms and greater then 3000 ms were removed. Each participant's data was also examined for outliers using box-and-whisker plots, and reaction times identified as extreme outliers

(> 3 *SD* from the participant's mean) were removed. In total 3.1% of the data was identified as extreme outliers and discarded.

Face Stimuli Characteristics: Picture Set

Given that two different stimuli sets were used in this study and that they differed somewhat in appearance, potential differences in reaction times to the Niedenthal (2000) and Ekman and Freisen (1975) picture series were assessed using a *t* test. The results showed that reaction times did not differ based on stimuli set, $t(69) = -1.21$, $p = .23$.

Session, Age, and Gender Analyses

In order to determine if the children enrolled in the 3 camp sessions differed in BI or in their performance on the Dot Probe task, ANOVA's were run with camp as the independent variable and BI T score and reaction time as the dependent variables. Participants did not significantly vary in terms of BI, $F(2, 67) = 1.09$, $p = .34$, and reaction time, $F(2, 66) = .26$, $p = .77$, across the three camp sessions. Therefore, the participants' scores from all sessions were combined for the subsequent analyses.

Potential gender differences in BI were examined using a *t* test. The males and females that were included in the three BI groups did not differ significantly in their BI total T scores, $t(68) = -.63$, $p = .53$. Males' and females' Dot Probe performance was also compared using an ANOVA with gender as the between subjects variable, and reaction times for the different face pairs and valid versus invalid trials as the dependent variables. Gender was not significantly related to reaction time, $F(1, 67) = .74$, $p = .39$, and gender did not significantly interact with either attentional bias scores, $F(1, 67) = .05$, $p = .83$ or response to different face pairs, $F(1, 67) = .48$, $p = .70$. Given that participant gender did not significantly influence any of the dependent variables, gender was not considered in the subsequent analyses.

To test whether age influenced BI or the Dot Probe reaction times, a series of Bivariate Pearson correlations were conducted. Age was significantly negatively correlated with BI, $r(70) = -.30$, $p = .01$, and age also had a significant negative relationship with average reaction time, $r(70) = -.54$, $p < .001$. However, age was not significantly related to attentional bias scores for either threat, $r(70) = .09$, $p = .46$, or novelty, $r(70) = -.11$, $p = .37$. Similarly, age did not significantly correlate with differences in responses to novel versus familiar face pairs, $r(70) = -.13$, $p = .29$, or angry versus neutral pairs, $r(70) = -.18$, $p = .15$. Therefore, while age is not related to the dependent variables of interest, it is negatively related to BI and adds variability to the reaction times on the Dot Probe task. In order to look at the effects of BI on reaction times over and above age, age was treated as a covariate in the following ANCOVA analyses.

Response to Threat and Novelty

Low, mid, and high BI children's reaction time means and standard deviations as function of threat and face familiarity are presented in Table 4.

Table 4:

Mean of Participants' Median Reaction Times (ms) as a Function of BI Group, Threat, and Face Pair Familiarity.

	Group					
	High BI (*n* = 22)		Mid BI (*n* = 25)		Low BI (n = 23)	
Condition	*M*	*SD*	*M*	*SD*	*M*	*SD*
Emotional Expression Preceding Probe						
Threatening	404.77	69.88	389.45	69.10	384.22	72.60
Neutral	413.19	83.69	390.94	80.15	390.78	85.13
Face Pair Familiarity						
Unfamiliar	418.28	82.44	397.23	93.02	393.08	79.94
Familiar	399.68	71.13	383.16	56.23	381.92	77.79

Median reaction times for each of the subjects in the three BI groups were calculated for each condition and entered into a 3 x 2 x 2 Mixed Design ANCOVA. There was one between subjects variable of BI grouping (low, medium, and high BI based on self-report total T scores). There were two within subjects variables of face pair familiarity (novel vs. familiar) and emotional expression (threatening vs. neutral). Age was entered as a covariate. There was a trend for all participants to attend to threatening faces over neutral faces, $F(1, 66) = 3.75$, $p = .06$. In contrast to the results of Study 1, attentional bias for faces displaying threatening emotions did not significantly interact with the participants level of BI, $F(2, 66) = .56$, $p = .57$. The overall trend to attend to threat did not significantly differ depending on whether the face pair presented was novel or familiar, $F(1, 66) = 2.70$, $p = .11$. Further, participants' responses to probes following novel versus familiar face pairs were not significantly different, $F(1, 66) = 2.96$, $p = .09$, though there was a trend for faster responses following familiar faces.

A second analysis was conducted to look at parent ratings of their children's BI and attention biases for threat. Because only 26 parents filled out both BI parent report questionnaires, participants could not be split into low, mid, and high BI groups on the basis of parent ratings. Thus, BI was treated as a continuous variable in this analysis. Attentional bias scores were calculated for each participant who had parent forms by subtracting their reaction times when the probe followed a threatening face from their reaction times when the probe followed a neutral face. Therefore, positive values would suggest an attentional bias towards threat. BIQ scores, BIS scores, age, and gender were entered into a hierarchical multiple regression predicting attentional bias. The results of the regression revealed that the participants' level of parent rated BI significantly predicted attentional bias, with BI being positively related to an attentional bias for threat. Parent ratings on the BIQ accounted for 23% of the variance in attentional bias scores. The BIS, age, and gender did not contribute significantly to the prediction of attentional bias. See Table 5 for a summary of the regression model findings.

Table 5:

Summary of Hierarchical Regression Analysis for Variables Predicting Attentional Bias for Threat (n = 26).

Variable	*B*	*SE B*	*β*	*p*
Step 1				
BIQ parent ratings	-0.91	0.34	-0.48	0.01
Step 2				
BIQ parent ratings	-1.01	0.59	-0.54	0.10
BIS parent ratings	1.26	5.67	0.07	0.83
Step 3				
BIQ parent ratings	-1.01	0.61	-0.53	0.12
BIS parent ratings	1.05	6.02	0.06	0.86
Age	1.19	7.94	0.03	0.76
Sex	6.89	22.58	0.06	0.88

Note. R^2 = .23 for Step 1; ΔR^2 = .002 for Step 2; ΔR^2 = .004 for Step 3

The discrepancy between the child self-report and parent report results were explored in a series of analyses. First, the possibility that the children for whom full parent and child self-report data were available may have differed in BI from other participants was explored. A One-way ANOVA was conducted with availability of parent forms (subjects in session three with parent forms vs. subjects in session three whose parents failed to return the forms) as the between subjects variable, and BIS and BIQ self report scores as the dependent variables. The children did not differ significantly in

BI as rated by the BIS self-report form, $F(1, 55) = .72$, $p = .40$. However there was a trend for children whose parents returned the forms to be higher on BI on the BIQ self report form, $F(1, 55) = 2.97$, $p = .09$. Due to this trend, a second analysis was performed to further explore whether the participants with parent reports were exceptional in terms of self-rated BI. BIS and BIQ scores of the participants with parent forms were compared to the BI means in the standardization sample using one-sample *t* tests. It was found that the children with parent forms did not differ significantly in BI on either the BIQ, $t(25) = .72$, $p = .48$ or the BIS, $t(25) = -.117$, $p = .91$, compared to the overall participant means.

A second possibility is that the discrepancies between child self-report and parent report results were due to differences in the way the data was organized and analysed. Specifically, when using the parent report forms, BI was treated as a continuous variable and the BIQ and BIS scores were entered separately into the regression (whereas in the ANOVA the participants were divided into groups on the basis of a combined total T score). To address whether these differences in the statistical analyses are responsible for the discrepant results, the data for the entire sample ($N = 188$) were re-analysed using the hierarchical regression procedure. Attentional bias scores were calculated for all participants by subtracting reaction times to probes following threatening faces from reaction times to probes following neutral faces. BIQ self report scores, BIS self-report scores, age, and gender were entered into a hierarchical multiple regression predicting attentional bias. The results confirmed the earlier ANCOVA findings, indicating that none of the variables entered as predictors were significantly related to attentional biases for threatening versus neutral faces ($p > .05$ for all predictors).

To assess attentional biases related to novelty, another 3 x 2 x 2 Mixed Design ANCOVA was performed on the median reaction times for each of the subjects in the three BI groups for each of the conditions (with age as a covariate). As in the previous ANCOVA, there was one between subjects variable of BI grouping (low BI, mid BI, and high BI based on self report total T scores). There were two within subject variables which measured attentional biases (towards novel versus familiar faces) and response to threat across trials (angry pairs vs. neutral pairs). All means and standard deviations for these analyses are found in Table 6.

Table 6:

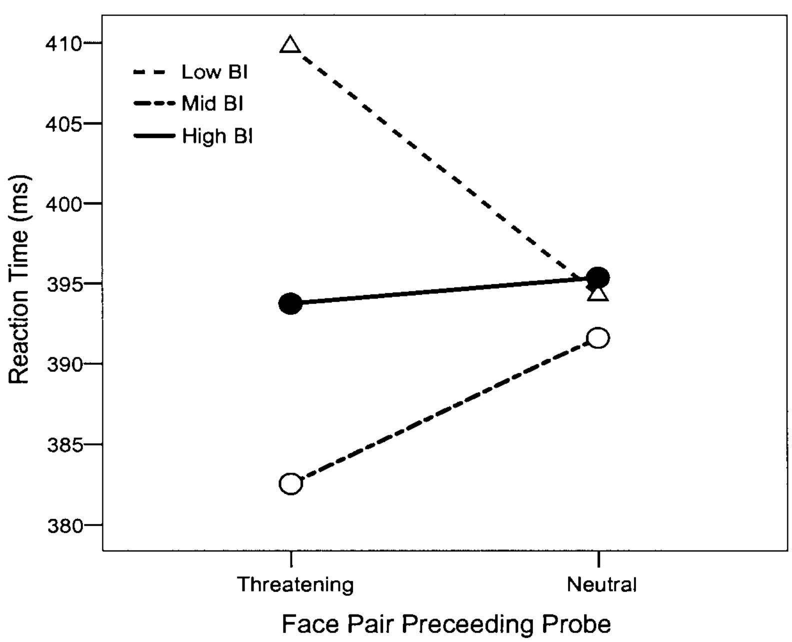
Mean of Participants' Median Reaction Times (ms) as a Function of BI Group, Novelty, and Face Pair Emotional Expression.

	Group					
	High BI (*n* = 22)		Mid BI (*n* = 25)		Low BI (n = 23)	
Condition	*M*	*SD*	*M*	*SD*	*M*	*SD*
Face Familiarity Preceding Probe						
Unfamiliar	411.84	74.51	387.14	68.42	385.49	78.11
Familiar	410.52	89.24	386.45	66.50	387.36	79.21
Face Pair Emotional Expression						
Threatening	412.08	75.67	382.21	68.23	392.55	87.57
Neutral	410.28	88.08	391.38	66.69	380.29	69.74

The ANCOVA results showed no evidence of attentional biases related to social novelty, $F(1, 66) = .14$, $p = .71$. This was true whether the face pairs displayed threatening or neutral expressions, $F(1, 66) = .13$, $p = .72$. However, there was a trend for participants of varying levels of BI to respond differentially to probes following angry versus neutral face pairs, $F(2, 66) = 2.46$, $p = .09$. Low BI children had faster median reaction times to probes following face pairs with neutral expressions, whereas children who scored in the mid range on BI exhibited the opposite pattern. High BI children's response times to the probes do not appear to differ for face pairs regardless of depicted affect. See Figure 3.

Figure 3:

Graph illustrating interaction between BI and response to probes following angry or neutral face pairs across trials.



As with attentional biases related to threat, a hierarchical regression was performed to assess whether parent rated BI, age, or gender predicted attentional bias to novelty (attentional bias scores were similarly calculated by subtracting reaction times to probes following novel faces from reaction times to probes following familiar faces). The parent BIQ scores were entered first, followed by the parent BIS scores, the participants' age, and sex. None of these variables significantly predicted attentional bias scores related to novelty ($p > .05$ for all predictors).

Additional analyses - Exploring differences between Study 1 and Study 2

Several of the findings from Study 1 were not replicated in Study 2. In an attempt to better understand the discrepant results, several additional analyses were used to explore potential reasons for the differences.

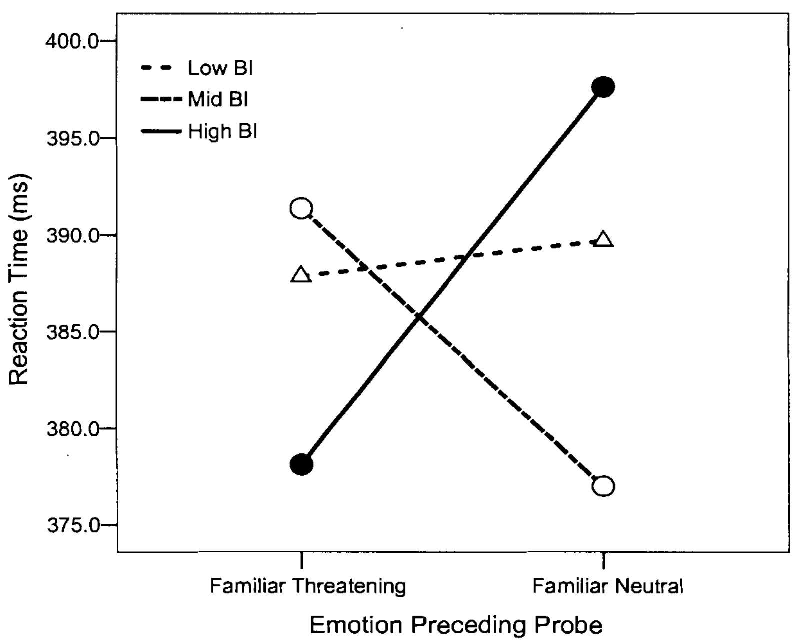
First, the rooms used for the research changed from Study 1 to Study 2, and the testing room in Study 2 was potentially more distracting because it was smaller and the children were seated in rows. If children were more distracted in Study 2, it was reasoned that this would be reflected in increased variability in responses on the Dot Probe task. Standard deviation scores for the original reaction time data (prior to the removal of inaccurate responses or outliers) were calculated for each participant in all the sessions for Study 1 versus Study 2. Using a One-way ANOVA, the variability of reaction time data was not found to be significantly different across the two studies, $F(3, 252) = .41$, $p = .75$.

Secondly, the Dot Probe task in Study 2 differed from the Dot Probe procedure used in Study 1 in several ways that could be responsible for the inconsistent findings across studies. The Dot Probe task in Study 2 had roughly twice as many trials and the trials were presented at a faster more demanding pace (all stimuli were presented at the 500 ms interval), which could have made it difficult for children to sustain close attention throughout the task. If so, it was reasoned that this would be reflected in differences in overall reaction times and/or the variability in reaction times from the first half to the second half of the study. These possibilities were assessed using two paired samples *t* tests. No significant differences were found in participants overall reaction times, $t(193) = .69$, $p = .49$, or the variability of reaction times, $t(193) = 1.20$, $p = .23$, in the first versus the second half of the Dot Probe task.

Another difference in the Dot Probe task used in Study 2 was that 14 of the trials showed two angry faces at once. Therefore, avoidance of threatening faces was not possible on these trials, which, combined with the increased number of trials, may have resulted in diminished effects due to desensitisation over the course of the experiment (although the total exposure time to angry faces was actually shorter in Study 2 because all faces were presented for only the shorter stimulus interval of 500 ms). This possibility was tested by re-running the ANCOVA for attentional biases related to threat using only the first 40 trials (this is equivalent to the number of trials in Study 1) that were presented to the participants. The findings revealed a significant BI (low, mid, high) by threat (threatening vs. neutral) by face pair (novel vs. familiar) interaction, $F(2, 66) = 3.95$, $p = .02$. To clarify this interaction, two separate ANCOVAs were performed examining BI and attentional biases in only novel versus only familiar face pairs. In these analyses, threat was found to differentially affect participants of varying levels of BI, but only when the faces were familiar, $F(2, 66) = 3.92$, $p = .03$. An examination of a plot of the interaction showed that high BI participants evidenced greater attention to threatening faces, whereas the mid BI group showed the opposite pattern, and the low BI group seemed unaffected by threat. See Figure 4.

Figure 4:

Graph illustrating significant interaction between BI and response to probes following familiar angry versus familiar neutral face pairs when only the first 40 trials were considered.



In the ANCOVA with only novel faces, there were no results that reached significance, although there was a trend for all the participants to respond faster to probes following threatening faces, $F(1, 66) = 3.28$, $p = .08$.

Discussion

In the Study 2 sample, the older the participant, the less BI they endorsed. This may suggest that most normal children become more open to novel situations and challenges as they age. However, the present study provides only cross-sectional evidence for this notion, and further longitudinal studies would help to clarify the course of inhibited behaviours in normal children. Because the main aim of this study was to look at the influence of BI on information processing biases (over and above age) differences in reaction times due to age were controlled for throughout the analyses.

Contrary to Study 1, children's self-rated BI was not related to selective attention for threat cues, and there was a trend for all participants to attend to threat. It is generally accepted that all individuals attend to threat if the threat is sufficiently severe (Mogg & Bradley, 1998; Yiend & Mathews, 2005). However, it has been shown that individual differences in anxiety determine the threshold at which attention is allocated to threat, with moderate threat being insufficient to capture attention in low anxious individuals (Wilson & MacLeod, 2003). The findings of Study 2 may suggest that the pictures used in the Dot Probe task were highly threatening and therefore captured attention in all children, regardless of their level of BI. However, this is not consistent with the results of Study 1, which showed that selective attention was dependent on the participant's level of BI, at least for the Ekman and Freisen (1975) picture set. The stimuli in Study 2 were not completely overlapping with stimuli in Study 1; as previously discussed half the stimuli came from the Ekman and Freisen (1975) picture set and the other half of the stimuli came from the Niedenthal picture set (2000). However, there were no reaction time differences in participants' responses to the Ekman and Freisen

(1975) photos versus the Niedenthal (2000) pictures in Study 2. Further, when parent ratings of BI were used, attentional bias for threat was related to the participants' level of BI, with higher BI children showing greater attentional bias for threat. This contrasts with the results obtained when using self reported BI, and supports the findings of Study 1, indicating that BI is related to biased attention for threat.

Another effect that was not replicated using self-report BI ratings, was that the response to novel versus familiar face pairs across trials did not differ depending on the participant's level of BI. Further, there was a trend for all participants to respond faster to the probe after two familiar faces were presented. This is not consistent with the results in Study 1 and goes against the previous interpretation that novel stimuli increase high BI children's readiness to respond. The findings of Study 2 also suggest that all participants habituate to stimuli with repeated exposures, which frees up cognitive resources to quickly respond to subsequent probes.

There was no evidence of attentional biases related to novelty. Further, the novelty of the faces presented did not influence attentional biases for threatening expressions. This lack of effect for novelty was also evident when parent BI ratings were used instead of self-ratings. Therefore, the hypothesis that children of varying levels of BI will respond differentially to novelty on an information processing task was not supported in this study. This is surprising given the findings of Study 1, and the fact that differential physiological and behavioural responses to novelty are core characteristics of BI.

Therefore, there are inconsistencies in the results of Study 1 and Study 2, as well as when using self-report versus parent report measures of BI. The failure to replicate the findings of Study 1 in Study 2 does not appear to be attributable to changes in the testing location, the participants' levels of BI, the addition of a second face stimuli set, or inattention due to the increased length of the Dot Probe task as all of these possibilities were systematically examined and eliminated. However, participants may have become desensitised to the angry faces over the increased number of trials, or perhaps due to the inclusion of trials where avoidance of threat was not possible. Specifically, when only the first 40 trials in Study 2 (which is the same number of trials used in Study 1) were considered, attentional bias for threat was found to depend on the participant's level of self-rated BI, in the familiar faces. This supports the notion that high BI children have a greater tendency to focus on threatening information, but suggests that this bias disappears with repeated exposures over the Dot Probe trials. Therefore, high BI children seem to habituate or become desensitised to threatening faces. With the novel faces there was a trend for all participants to attend to threat, which could imply that when the face expressing anger is unfamiliar, this was sufficiently threatening to evoke an attentional bias in all participants. Importantly, the fact that such different findings emerged when only the first half of the trials were considered suggests that the number of trials is a key variable that should be considered in future research using the Dot Probe task.

The potential reasons for the inconsistent findings when using the parent ratings versus the self-ratings in Study 2 were also explored. These discrepant results were not found to be due to differences in the way BI was defined or the statistical procedures used when analysing the parent and self-report data. Further, the children whose parents returned the forms were not found to be exceptional in terms of BI. It seems that in this sample the parents were better able to identify children who selectively attend to threat. Unexpectedly, the parent ratings of children's BI were not significantly related to the children's self-ratings on either the BIS or the BIQ.

This is the first time that the BIQ has been used as a self report measure, therefore, there is no other research indicating how it would be expected to compare to the parent report measure. These results suggest that the ratings obtained from parents and children on the BIQ are unrelated. However, ratings obtained from the BIS self and parent reports in this study were also not correlated, which is not consistent with prior research on a modified version of the BIS. Specifically, Muris, Meesters, and Spinder (2003) looked at the relationship between parent and child rated inhibition on modified BIS scales in children aged 11-15. The BIS version used by Muris and colleagues (2003) was very similar to the BIS version used in Study 1 and Study 2. The only exception is that the BIS version used in the present studies asked about inhibition when interacting with an "unfamiliar person" (e.g. "I am shy when I have to talk to an unfamiliar person"), whereas Muris and colleagues (2003) doubled the items to form two BIS scales asking about inhibited behaviours when with an "unfamiliar adult" (e.g. "I am shy when I have to talk to an unfamiliar adult") and when with an "unfamiliar child" (e.g. "I am shy when I have to talk to an unfamiliar child"). Muris and colleagues (2003) found that the parent and child ratings were significantly correlated on both the BIS unfamiliar child scale (r (297) = .47, $p < .001$) and the BIS unfamiliar adult scale (r (297) = .44, $p < .001$). Of course, Muris et al.'s (2003) variation of the BIS could have resulted in better agreement because the questions are more specific. However, Muris et al. (2003) also administered Part 2 of the BII in the same format in which it was administered (but not included in the analyses) in this study, and again they found that parent and child categorizations were significantly related (r (297) = .42, $p < .001$) and the results of

Study 2 did not (*r* (28) = .31, *p* = .12). Alternately, Muris et al. (2003) may have obtained better agreement with parent and child ratings because their sample of children were 11 – 15 years old, and perhaps older children's perceptions of their behaviours are more similar to their parents' perceptions. However, in the present sample whose ages ranged from 7 – 14 years, age was not related to the magnitude of discrepancy between child and parent ratings. Therefore, the low correspondence between parent and child ratings probably has more to do with the small sample of parents that participated in this study. The small number of parents who returned their BI questionnaires (and thus the limited power to detect a significant relationship) was a limitation of the current study.

CONCLUSIONS AND OVERALL DISCUSSION FOR STUDY 1 AND STUDY 2

The findings of Study 1 indicated that children with varying levels of BI respond differentially to novelty on an information processing task. However, there was no evidence for this in Study 2, which had a larger sample and explored responses to novelty in several different ways. Specifically, novelty was not found to influence attention allocation, the speed of responses across trials, or the magnitude of attentional biases for threat. Therefore, while high BI children are known to differ in their comfort, behaviour, and avoidance of novel social situations, it seems that they do not have attentional biases related to novelty or differential responses to novel versus familiar faces related to their readiness to respond.

The findings of Study 1 and Study 2 provide mixed and inconclusive evidence regarding attentional biases for threat as a function of BI. Attentional biases for threat were significantly related to self-rated BI in Study 1 and parent rated BI in Study 2. However, in Study 2, self-rated BI did not interact with preferential attention for threat cues. Therefore, the evidence is inconclusive concerning whether BI children process information with the same biases in attention that are found in anxious populations. The discrepancy in results across these studies indicates that the tendency toward biased attention for threat is not robust and may be easily affected by changes in the experimental protocol. Nevertheless, because there is partial support to suggest that BI children exhibit biased attentional processing, this is a worthwhile area to follow up in future research.

One variable that is important to consider in future studies, is the number of times that threatening information is presented, as this research suggests that participants may become desensitised to threatening stimuli. This was evidenced by the fact that when only the first half of the trials in Study 2 were considered, attentional bias was related to self-rated BI with the familiar faces (when the face was both threatening and unfamiliar there was a trend for all participants to attend to threat). The finding that the number of exposures influenced attentional bias results is consistent with some previous research. For instance, Strauss, Allen, Jorgensen, and Cramer (2005) found that with the Stoop task interference effects, which are taken to be indicative of attentional bias, were less significant with repeated exposures. Lui, Qian, Zhou, and Wang (2006) also recently examined the effect of repeated exposure to stimuli on the Dot Probe task by presenting the same pictures in four test blocks. They found that participants with high trait anxiety showed a significant attentional bias for highly threatening pictures on the second and third blocks, but that this effect became insignificant with the fourth block. Lui and colleagues (2006) interpreted their results as evidence of habituation to threatening stimuli with repeated exposures. Although, this argument is weakened by the fact that on the first block, which should have shown the largest effects, they found only a "marginally significant" bias for threat ($p = .09$). Therefore, Lui et al.'s (2006) findings may be attributable to alternative explanations, such as a lack of reliability in the task.

Schmukle (2005) recently assessed the internal consistency and retest reliability of the Dot Probe task and found that it was an unreliable measure of attention allocation in a non-clinical sample. Thus, the possibility that the inconsistent findings obtained in Study 1 and Study 2 are attributable to unreliability of the Dot Probe task cannot be ruled out. Schmukle's (2005) study shows that, despite the Dot Probe task's popularity, it may not be an ideal measure to use in future work. At a minimum, Schmukle's results indicate a need to assess the reliability of response measures, which is currently not generally done. Therefore, it is critical to the study of attentional processes that a response measure with adequate psychometric properties is identified.

Additionally, to further our understanding of selective attention for threatening information, the component processes underlying preferential processing of one stimulus over another should be broken down. The present studies aimed only to assess whether BI children exhibited an attentional bias for threat cues, however, the mechanisms responsible for this potential attentional preference were not explored. Therefore, in addition to clarifying whether BI children reliably exhibit the attentional biases associated with anxiety, it would be useful to assess whether this greater focus on threat cues is due to attention being captured by threat, difficulties disengaging from threatening stimuli, or both these processes in combination. The mechanisms responsible for selective attention to threat cues are beginning to be assessed in non-clinical samples (e.g. Fox, Russo, Bowles, & Dutton, 2001; Koster, Crombez, Verschuere, & De Houwer, 2004; Yiend & Mathews, 2001), however this has apparently not been explored with BI individuals.

Another aspect of attention referred to by Lonigan and colleagues (2004) as effortful control may also bear relevance to the results of this research. Effortful control is the ability to effortfully redirect and control attention following initial automatic preattentional biases. Lonigan and colleagues (2004) propose that the relationship between temperament and elevated anxiety is possibly mediated by attentional bias for threat cues, but that this automatic attention bias and the risk for anxiety is moderated by effortful control. Specifically, as hypothesized in Study 1 and Study 2, high BI children's attention may automatically be drawn to threat in their environment even before conscious processing has had a chance to occur, and this focus on threatening information may make them susceptible to anxiety. However, once enough time has elapsed for conscious processing to take place, the ability to shift attention away from threat towards safety relevant information would aid affect regulation and thus reduce the risk for anxiety. Lonigan et al. (2004) suggest that the inconsistent results that are sometimes obtained concerning anxiety related attentional bias may be due to researchers neglecting to assess effortful control in studies where stimuli were presented long enough for effortful control of attention to be exerted. Therefore, if children make effortful shifts in their attention within the 500 ms interval used in Study 1 and Study 2, then it is possible that effortful control could have accounted for the variability in the findings. Specifically, high BI groups may have similar preattenional biases for threat, but differ in their responses at 500 ms due to the participants' levels of effortful control. The most informative test of this hypothesis would be to follow BI children longitudinally and assess whether an automatic attentional bias towards threat, along with a reduced ability to exert effortful control over this bias, predicts which BI children develop clinical anxiety.

Taken together, the results of this work suggest that attentional bias may be a factor in information processing in high BI children. It is important to pursue further research in this area because it offers a potential mechanism between BI temperament and clinical anxiety. While more studies are needed to clarify this research, such work may have implications for the development of preventative and treatment interventions. We know that attentional bias for threat is related to greater vulnerability to anxiety

(Mathews & MacLeod, 2002). Identifying BI children with selective attention for threat and reducing these biases may prove to be a valuable focus for preventative efforts. The potential importance of this area is underscored by accumulating research looking at attentional biases and treatment interventions for anxiety. For example, Mogg, Bradley, Millar, and White (1995) found that undergoing cognitive behavioural therapy for anxiety reduced attention biases for threatening information, and that treatment gains appeared to be mediated by changes in attention allocation. Given such findings, researchers have suggested that direct attentional training exercises aimed at eliminating anxiety related biases and potentially inducing benign attentional biases would be a valuable addition to treatment interventions (Mohlman, 2004; Mathews & MacLeod, 2002). As discussed, Hazen, Vasey, and Schmidt (2002) demonstrated that attentional re-training resulted in greater reduction of anxiety symptoms in a non-clinical sample than a placebo treatment. Thus, continued research on the attentional biases of BI children may not only help us to understand the mechanisms that link inhibited temperament to clinical anxiety, but could also potentially provide avenues for preventing these disorders.

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APPENDICES

Appendix A: Behavioral Inhibition Instrument – Self Report

Part one

For each of the questions below, rate how frequently the statement describes you. The rating scale has 4 points with 1 meaning that you are never like the statement, 2 meaning that you are sometimes like the statement, 3 meaning that you are often like the statement, and 4 meaning that you are always like the statement.

1. I am shy when I have to talk to an unfamiliar person

Never	Sometimes	Often	Always
1	2	3	4

2. I talk easily to an unfamiliar person

Never	Sometimes	Often	Always
1	2	3	4

3. I feel nervous when I have to talk to an unfamiliar person

Never	Sometimes	Often	Always
1	2	3	4

4. I feel good and I am able to laugh, when I talk to an unfamiliar person

Never	Sometimes	Often	Always
1	2	3	4

Part two

Please write and X after *one* of the following three categories based on which category best describes you. Be sure to read each description before choosing the one that you feel is closest to the way you are.

1. As long as I remember, I am shy when I have to talk to an unfamiliar person. On such occasions, I am nervous, I am not able to laugh, and I do not know what to say _____
2. As long as I remember, I talk easily to an unfamiliar person. On such occasions, I feel good, I am able to laugh, and I know precisely what I have to say _____
3. I am someone falling in between 1 and 2 _____

Appendix B: Behavioral Inhibition Instrument – Other Report

Please assign each child in the group to one of the following three categories by placing the number corresponding to their name (see class list) in the blank space following the description. Assign each child on the basis of what description they are *most* like. Please be sure to read each of the following descriptions before beginning to assign the students.

<u>Category one</u>

This child is shy when they have to talk to an unfamiliar person. On such occasions, they seem nervous, they are not able to laugh, and they do not know what to say.

Please list the file numbers of the children who best fit the description in category one here:

<u>Category two</u>

This child talks easily to an unfamiliar person. On such occasions they seem like they feel good, they are able to laugh, and they know precisely what they have to say.

Please list the file numbers of the children who best fit the description in category two here:

<u>Category three</u>

This child falls somewhere between category one and category two.

Please list the file numbers of the children who best fit the description in category two here:

Appendix C: Behavioral Inhibition Questionnaire – Self Report

The following statements describe behaviour in different situations. Each statement asks you to judge whether you perform the behaviour described "*hardly ever*", "*rarely*", "*once in a while*", "*sometimes*", "*often*", "*very often*", or "*almost always*". Please circle the number "1" if you "*hardly ever*" perform the behavior, the number "2" if you "*infrequently*" perform the behaviour, etc. Try to answer the questions the best you can, based on how you think you compare with other children who are about the same age.

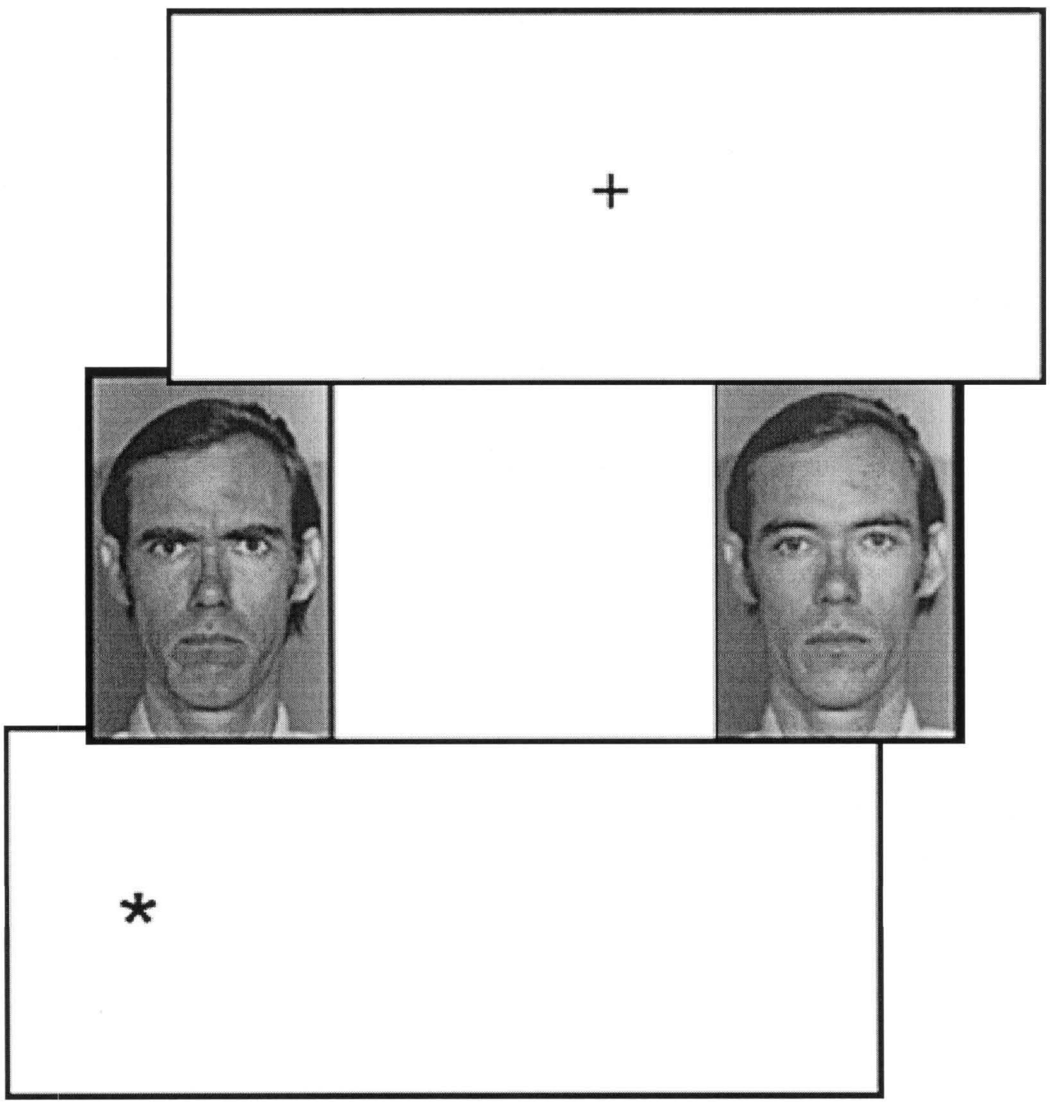
1 Hardly Ever	2 Rarely	3 Once in a While	4 Sometimes	5 Often	6 Very Often	7 Almost Always

1. I approach new situations or activities very hesitantly	1	2	3	4	5	6	7
2. I will happily approach a group of unfamiliar children to join in their play	1	2	3	4	5	6	7
3. I am very quiet around new (adult) guests to our home	1	2	3	4	5	6	7
4. I am cautious in activities that involve physical challenge (e.g., climbing, jumping from heights)	1	2	3	4	5	6	7
5. I settle in quickly when I visit the homes of people I don't know well	1	2	3	4	5	6	7
6. I enjoy being the centre of attention	1	2	3	4	5	6	7
7. I am comfortable asking other children to play	1	2	3	4	5	6	7
8. I am shy when first meeting new children	1	2	3	4	5	6	7
9. I am happy to perform in front of others (e.g., singing, dancing)	1	2	3	4	5	6	7
10. I quickly adjust to new situations (e.g., school, camp, after school activities)	1	2	3	4	5	6	7
11. I am reluctant to approach a group of unfamiliar children to ask to join in	1	2	3	4	5	6	7

1 Hardly Ever	2 Rarely	3 Once in a While	4 Sometimes	5 Often	6 Very Often	7 Almost Always

12. I am confident in activities that involve physical challenge (e.g., climbing, jumping from heights)	1	2	3	4	5	6	7
13. I am independent	1	2	3	4	5	6	7
14. I seem comfortable in new situations	1	2	3	4	5	6	7
15. I am very talkative to adult strangers	1	2	3	4	5	6	7
16. I am hesitant to explore new play equipment	1	2	3	4	5	6	7
17. I get upset at being left in new situations for the first time (e.g., school, camp, after school activities)	1	2	3	4	5	6	7
18. I am very friendly with children I have just met	1	2	3	4	5	6	7
19. I tend to watch other children, rather than join in their games	1	2	3	4	5	6	7
20. I dislike being the centre of attention	1	2	3	4	5	6	7
21. I stay close to my parents when we visit the homes of people we don't know well	1	2	3	4	5	6	7
22. I happily approach new situations or activities	1	2	3	4	5	6	7
23. I am outgoing	1	2	3	4	5	6	7
24. I seem nervous or uncomfortable in new situations	1	2	3	4	5	6	7
25. I happily chat with new (adult) visitors to our home	1	2	3	4	5	6	7
26. It takes me many days to adjust to new situations (e.g., school, camp, after school activities)	1	2	3	4	5	6	7
27. I am reluctant to perform in front of others (e.g., singing, dancing)	1	2	3	4	5	6	7
28. I happily explore new play equipment	1	2	3	4	5	6	7
29. I am very quiet with adult strangers	1	2	3	4	5	6	7

Appendix D: Example of Stimuli Used in Dot Probe Trials with Threatening and Neutral Faces (Which are either Novel or Familiar)



Appendix E: Behavioral Inhibition Instrument – Parent Form

Part one

For each of the questions below, rate how frequently the statement describes your child. The rating scale has 4 points with 1 meaning that he/she is never like the statement, 2 meaning that he/she is sometimes like the statement, 3 meaning that he/she is often like the statement, and 4 meaning that he/she is always like the statement.

1. My child is shy when he/she has to talk to an unfamiliar person

Never	Sometimes	Often	Always
1	2	3	4

2. My child talks easily to an unfamiliar person

Never	Sometimes	Often	Always
1	2	3	4

3. My child feels nervous when he/she has to talk to an unfamiliar person

Never	Sometimes	Often	Always
1	2	3	4

4. My child feels good and is able to laugh, when he/she talks to an unfamiliar person

Never	Sometimes	Often	Always
1	2	3	4

Part two

Please write and X after *one* of the following three categories based on which category best describes your child. Be sure to read each description before choosing the one that you feel is closest to the way he/she is.

1. As long as I remember, my child is shy when he/she has to talk to an unfamiliar person. On such occasions, he/she is nervous, he/she is not able to laugh, and he/she does not know what to say _____

2. As long as I remember, my child talks easily to an unfamiliar person. On such occasions, he/she feels good, he/she is able to laugh, and he/she knows precisely what to say _____

3. My child is someone falling in between 1 and 2 _____

Appendix F: Behavioral Inhibition Questionnaire – Parent Form

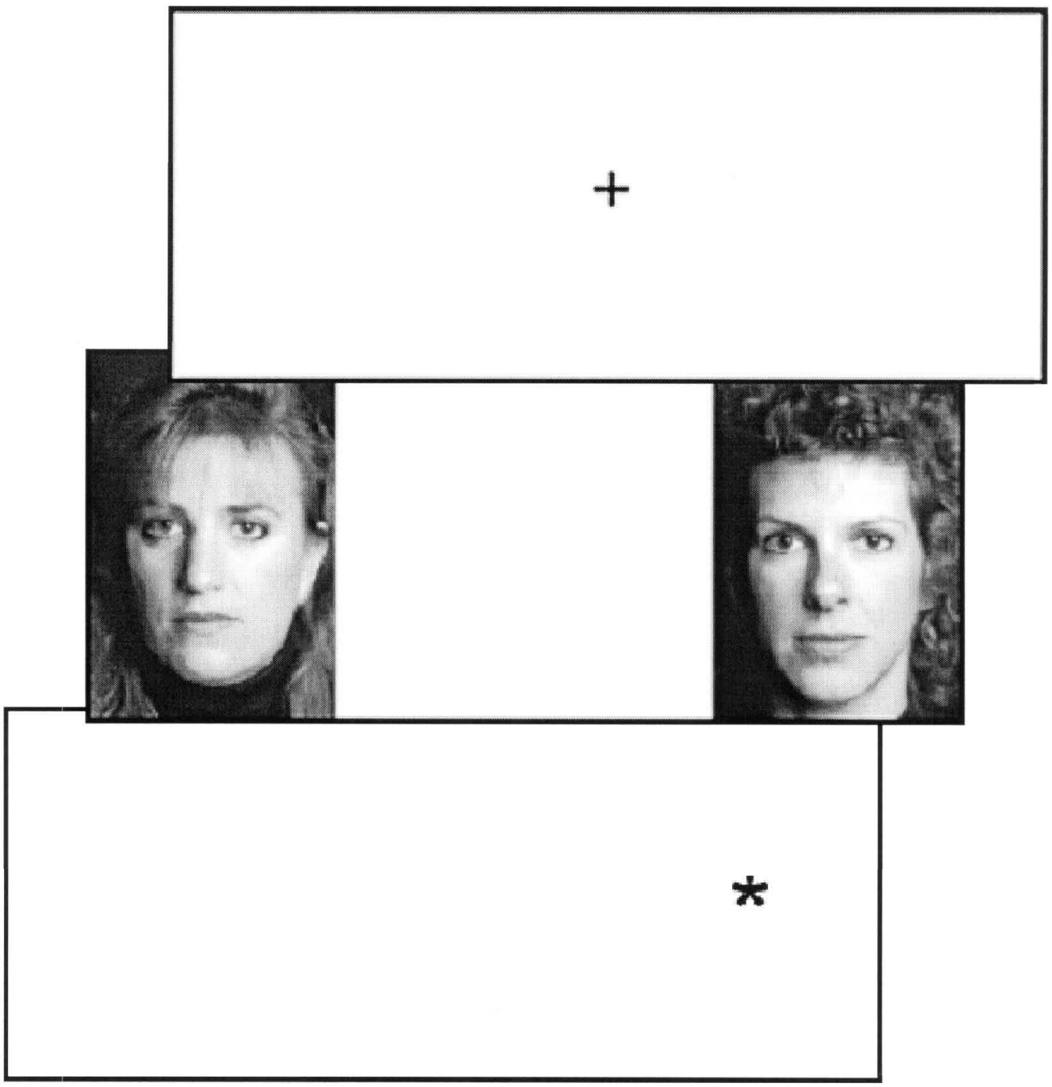
The following statements describe children's behaviour in different situations. Each statement asks you to judge whether that behaviour occurs for your child "*hardly ever*", "*infrequently*", "*once in a while*", "*sometimes*", "*often*", "*very often*", or "*almost always*". Please circle the number "1" if the behaviour "*hardly ever*" occurs, the number "2" if it occurs "*infrequently*", etc. Try to make this judgement to the best of your ability, based on how you think your child compares with other children about the same age.

1 Hardly Ever	**2** Rarely	**3** Once in a While	**4** Sometimes	**5** Often	**6** Very Often	**7** Almost Always

1. Approaches new situations or activities very hesitantly	1	2	3	4	5	6	7
2. Will happily approach a group of unfamiliar children to join in their play	1	2	3	4	5	6	7
3. Is very quiet around new (adult) guests to our home	1	2	3	4	5	6	7
4. Is cautious in activities that involve physical challenge (e.g., climbing, jumping from heights)	1	2	3	4	5	6	7
5. Settles in quickly when we visit the homes of people we don't know well	1	2	3	4	5	6	7
6. Enjoys being the centre of attention	1	2	3	4	5	6	7
7. Is comfortable asking other children to play	1	2	3	4	5	6	7
8. Is shy when first meeting new children	1	2	3	4	5	6	7
9. Is happy to perform in front of others (e.g., singing, dancing)	1	2	3	4	5	6	7
10. Quickly adjusts to new situations (e.g., school, camp, after school activities)	1	2	3	4	5	6	7
11. Is reluctant to approach a group of unfamiliar children to ask to join in	1	2	3	4	5	6	7

	1 Hardly Ever	2 Rarely	3 Once in a While	4 Sometimes	5 Often	6 Very Often	7 Almost Always
12. Is confident in activities that involve physical challenge (e.g., climbing, jumping from heights)	1	2	3	4	5	6	7
13. Is independent	1	2	3	4	5	6	7
14. Seems comfortable in new situations	1	2	3	4	5	6	7
15. Is very talkative to adult strangers	1	2	3	4	5	6	7
16. Is hesitant to explore new play equipment	1	2	3	4	5	6	7
17. Gets upset at being left in new situations for the first time (e.g., school, camp, after school activities)	1	2	3	4	5	6	7
18. Is very friendly with children he or she has just met	1	2	3	4	5	6	7
19. Tends to watch other children, rather than join in their games	1	2	3	4	5	6	7
20. Dislikes being the centre of attention	1	2	3	4	5	6	7
21. Stays close to me when we visit the homes of people we don't know well	1	2	3	4	5	6	7
22. Happily approaches new situations or activities	1	2	3	4	5	6	7
23. Is outgoing	1	2	3	4	5	6	7
24. Seems nervous or uncomfortable in new situations	1	2	3	4	5	6	7
25. Happily chats to new (adult) visitors to our home	1	2	3	4	5	6	7
26. Takes many days to adjust to new situations (e.g., school, camp, after school activities)	1	2	3	4	5	6	7
27. Is reluctant to perform in front of others (e.g., singing, dancing)	1	2	3	4	5	6	7
28. Happily explores new play equipment	1	2	3	4	5	6	7
29. Is very quiet with adult strangers	1	2	3	4	5	6	7

Appendix G: Example of Stimuli used in Dot Probe Trials with Neutral Novel and Neutral Familiar Faces



Appendix H: Example of Stimuli Used in Dot Probe Trials with Angry Novel and Angry Familiar Faces