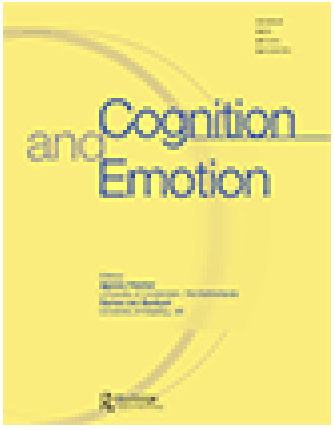
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Attentional bias to respiratory- and anxiety-related threat in children with asthma

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Attentional bias to respiratory- and anxiety-related threat in children with asthma

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This study investigated attentional biases in children with asthma. The study aimed at testing whether children with asthma are vigilant to asthma and/or anxiety cues. Thirty-six children (18 with asthma and 18 healthy controls) aged 9–12 completed a computerised dot probe task designed to measure attentional bias to three different categories of words: asthma, anxiety symptom and general negative emotion. Main caregiver anxiety was also assessed, as was frequency of inhaler use for those with asthma. Children with asthma showed an attentional bias towards asthma words but not anxiety or general negative emotion words. Children without asthma showed no significant attentional biases to any word categories. Caregiver anxiety was correlated with asthma word attentional bias in the asthma group. The findings indicate that attentional bias is present in children with asthma. Further research is required to ascertain if this exacerbates or maintains health-related problems.

Keywords: Attentional bias; Asthma; Children; Anxiety.

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Asthma is a chronic respiratory disease which affects up to 30% of children worldwide (Pearce et al., 2007). The disease comprises episodes or attacks where breathing is affected, and the individual experiences symptoms such as a tight chest, wheezing, shortness of breath and coughing. Treatment typically involves attempting to reverse these symptoms, either concurrently with bronchodilators (commonly known as reliever inhalers), or over a consistent period with a prescription of corticosteroids (commonly known as preventer inhalers). Everyday treatment of asthma predominantly relies on self-management, which in turn has been shown to rely on several factors such as knowledge of asthma and self-efficacy. Self-efficacy equates to having the confidence to be able to accurately interpret symptoms and consequently utilise appropriate self-care with medication,

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which has been suggested to be experience rather than education based (Mancuso, Sayles, & Allegrante, 2010). This hypothesis suggests that those who have had positive experiences of managing their asthma would be more confident in managing the illness. Individuals with asthma are required to utilise their reliever inhaler as and when they need it, and if they are prescribed a preventer inhaler this is used on a dosage basis. This treatment can be an effective way of managing asthma; however, research has shown that poor management of the illness is still a common occurrence in both child and adult populations (Demoly, Gueron, Annunziata, Adamek, & Walters, 2010). A significant problem in relation to the management of the illness is the inappropriate use of prescribed medication. Specifically, frequent or overuse of bronchodilators is recognised as an indicator of poor control and has been linked to recurrent use of health care facilities (Anis et al., 2001), exacerbated symptoms and even increased mortality (Anderson et al., 2005). The consensus is that asthma is a complex chronic condition and furthermore, the presence of comorbid psychological problems has been cited to contribute to difficulties in controlling and managing the illness (De Groot, Duiverman, & Brand, 2010).

Indeed, research has consistently found a positive relationship between childhood asthma and anxiety (Bussing, Burket, & Kelleher, 1996; Katon et al., 2007; Vuillermin et al., 2010). More specifically, researchers have considered the different types of anxiety disorders related to asthma; however, there have been mixed results, with no definite anxiety disorder relating to asthma. For example, childhood asthma has been associated with panic (Goodwin, Pine, & Hoven, 2003), generalised anxiety, obsessions, compulsions and panic (Vuillermin et al., 2010), and social phobia (Katon et al., 2007). A recent article emphasised the strong relationship between asthma and anxiety, and suggested that amongst other explanations, anxiety could be secondary to living with the stress of a chronic health condition (Goodwin, Bandiera, Steinberg, Ortega, & Feldman, 2012). However, the authors also highlighted the continued lack of certainty regarding the mechanism behind this relationship and the necessity for longitudinal research to help understand it (Goodwin et al., 2012). General anxiety literature suggests that parental anxiety is a contributing factor in the development of childhood anxiety (Donovan & Spence, 2000). More specifically, and in relation to asthma, is that children with more anxious mothers report higher levels of anxiety and lower asthma-related quality of life (Sales, Fivush, & Teague, 2008).

The comorbidity of anxiety with asthma has been shown to perpetuate physical symptoms; individuals with asthma can misconstrue panic symptoms as asthma symptoms which consequently can increase the rate of panic in youths with asthma (Goodwin et al., 2003). Within panic research, it has been found that those with panic disorder show high rates of vigilance to physical cues which can maintain the anxiety (Schmidt, Lerew, & Trakowski, 1997). Due to the maintenance factor of attention to symptoms in anxiety disorders, vigilance to physical cues is discouraged within psychological treatment (Westbrook, Kennerley, & Kirk, 2007). Paradoxically, for an individual with asthma, the nature of self-medicating with inhalers actually requires the individual to be vigilant to physical cues. Here, attention is something that is necessary for the management of asthma, but could also be a maintaining factor in problems with the illness.

The role of attention in the cause and maintenance of anxiety disorders has drawn considerable interest. Researchers have consistently shown that an individual's attention automatically orients to emotionally threatening information, the purpose of which is to allow a faster response to threat (Cisler & Koster, 2010). It has now been demonstrated in a large meta-analysis that people with anxiety disorders show attentional biases towards threat (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & Van Ijzendoorn, 2007). Furthermore, this finding has been replicated consistently in child research (cf., Salum et al., 2012). Research has also indicated that cognitive processing of information relates to maintenance of problems, such as anxiety and also health-related difficulties.

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Boyer et al. (2006) showed that children with recurrent abdominal pain showed patterns of attentional bias to pain-related stimuli, which correlated with severity of pain. In relation to chronic health problems, attentional bias to symptoms has also been linked with the maintenance of the illness (Dehghani, Sharpe, & Nicholas, 2003). Findings in chronic pain research have produced a mixed picture, with two recent meta-analyses providing different results: Schoth, Nunes, and Liossi (2012) showed that those with chronic pain displayed greater attentional bias to pain-related stimuli compared to controls, whereas Crombez, Van Ryckeghem, Eccleston, and Van Damme (2013) showed no difference in attentional bias between those with chronic pain and controls.

To date, only two studies have investigated attentional biases in people with asthma (De Peuter et al., 2007; Jessop, Rutter, Sharma, & Albery, 2004). While both studies showed a bias towards asthma-related stimuli, only Jessop et al. (2004) found that this bias was greater for people with asthma over healthy controls. In addition, Jessop et al. (2004) demonstrated that attentional bias was associated with adherence to asthma medication. No asthma-related attentional bias research has been carried out in paediatric populations to the authors' knowledge; however, generally, attentional bias findings have been replicated in child and adolescent populations (Vasey & Daleiden, 1995). In terms of current research and clinical practice, an emphasis has been placed on targeting early interventions towards child and adolescent physical and mental health in order to prevent the established trajectory into adulthood (Department of Health, 2011), and therefore building on research within younger populations meets this demand.

It is already recognised that there is an association between anxiety and asthma, however if a contributing factor to this in child populations is implicit cognitive processing, establishing this could have clinical implications for the treatment of comorbid asthma and anxiety. Given that there is a determined link between experiencing asthma and panic-related difficulties, it would be helpful to ascertain whether those with asthma show an attentional bias to panic-related anxiety symptom cues, as well as asthma cues. Where Jessop et al. (2004) were interested in the use of the preventer inhaler, research has shown that bronchodilator medication (reliever inhaler) is commonly overused (Cole, Seale, & Griffiths, 2013), and that there can be serious health implications (Anderson et al., 2005). The present study therefore sought to examine whether attentional bias is related to inhaler use (are those who show attentional biases to asthma cues more likely to use their inhaler?). Childhood anxiety has also been related to caregiver anxiety (Donovan & Spence, 2000) and assessing attentional bias in the context of systemic influences is particularly important when considering clinical implications for the treatment of asthma and anxiety in child populations.

The primary aim of the study was to test the hypothesis that children with asthma would show a greater attentional bias to asthma and/or anxiety cues compared to those without asthma. Additionally, it was hypothesised that there would be no attentional bias to words which are generally associated with negative emotions, suggesting that the attentional bias cannot be explained by a sensitivity to all emotional stimuli. The secondary aim was to ascertain whether attentional bias was related to caregiver anxiety or inhaler use which may be indicative of problems with managing the illness.

METHOD

Design

The study used a mixed design. Here, the between-groups factor was asthma status (asthma vs. no asthma), and the within-groups factor was threat word type (asthma vs. anxiety symptom vs. general negative emotion). The dependent variable was the attentional bias score for each category of word.

Participants

Eighteen children with asthma (14 males and 4 females) and 18 children without asthma (14

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males and 4 females) participated in this research. The age range of the sample was between 108 and 150 months (i.e., 9–12 years). The participants with asthma were recruited from three hospital-based asthma clinics within Scotland between July 2013 and February 2014. In terms of the demographics of the community from which the asthma clinics were based, 91% of the population is White British (National Records of Scotland [Census], 2011). The selection criteria for the participants in this group were that they (1) had a moderate to severe diagnosis of asthma, (2) were prescribed a reliever inhaler, (3) were aged 9–12 years at the time of the research, (4) were free of any respiratory infection at the time of the research; and (e) could read and write in English. Participants in the control group were recruited from a school in Scotland. The selection criteria for these participants were the same as the experimental group, apart from (1) and (2) where they did not have a diagnosis of asthma and did not use an inhaler. Participants in the control group were recruited second: each control group participant was invited to take part based on and exact match of gender and ethnicity and as close as possible on age. A power analysis was carried out using G*Power 3.1.7 (Faul, Erdfelder, Lang, & Buchner, 2007) which indicated that in order to achieve a 0.8 level of power with a medium effect size ($f = 0.25$), for analysis of variance (ANOVA) 34 participants would be required across the two groups. It was therefore concluded that 18 participants in each group was sufficient. Each child's main caregiver also participated in the research. The two groups were matched in terms of gender ratio. There was also no significant difference between the groups in age, $t(34) = 0.38$, $p = .70$, child ethnicity, $\chi^2(1, N = 36) = 0.00$, $p = 1.00$, parent ethnicity, $\chi^2(1, N = 36) = 0.36$, $p = .55$, or the amount of data removed due to incorrect responses or outliers $t(34) = 0.43$, $p = .67$.

Ethical approval

The study was granted ethical approval by the South East Scotland Research Ethics Committee and each relevant NHS Health Board Research and Development department.

Measures

Dot *probe task*

The dot probe is a measure of attentional bias as used in previous studies (MacLeod, Mathews, & Tata, 1986) and has been successfully replicated for use with children as young as 7 years (Vasey & Daleiden, 1995). The dot probe was presented on a Sony Vaio E Series, Intel Inside CORE i5 15.5" laptop screen, and the participants were seated approximately 60 cm from the screen (Hunt, Keogh, & French, 2007). For each trial, a fixation cross appeared on the screen for 500 milliseconds (ms). This was then replaced by a word pair consisting of either a threat–neutral or a neutral–neutral pair. Threat words were those words which fell into asthma, anxiety symptom or general negative emotion categories. Words were presented with one word above the other for 1250 ms at a distance of 3 cm apart. This presentation time is in line with suggested times for research with children to account for slower processing speeds compared to adults (Vasey & Daleiden, 1995). The response latencies were timed from the point that a probe in the shape of a dot appeared on the screen in place of either the top or the bottom word, until either the "I" or the "M" key on the keyboard was pressed, or after 3000 ms. The "I" key corresponded to the dot replacing the top word, and the "M" key corresponded to the dot replacing the bottom word. These keys were chosen to allow the participant to respond using one hand, and for the upper and lower dot position to be represented on the keyboard with an upper and lower key, to minimise errors. This "probe position" method was chosen as it has been deemed to be more straightforward (Mogg & Bradley, 1999), and therefore less demanding for children. After this time elapsed or a correct key was pressed, the participant was presented with another fixation cross before the next trial. Both the threat word and the dot probe could appear in either the top

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position or bottom position in equal probability which gave rise to four conditions: probe upper-threat word upper, probe upper-threat word lower, probe lower-threat word lower and probe lower-threat word upper. Within each of the three word categories, these four conditions occurred for an equal number of times.

Dot probe stimuli

The stimuli consisted of 96 different word pairs, comprised of 48 neutral–neutral word pairs and 48 threat–neutral word pairs. Of the 48 threat words, there were three separate categories each made up of 16 words; anxiety symptom, asthma or general negative emotion words. In order to maximise testing, the 48 threat–neutral word pairs were repeated so they each occurred twice, giving 144 total trials when combined with the 48 neutral–neutral word pairs. All word pairs were presented in a random order for each participant. The threat words were chosen from previous attentional bias research (Hunt et al., 2007; Jessop et al., 2004; Doost, Moradi, Taghavi, Yule, & Dalgleish, 1999). Neutral words were selected to match the threat words on both word length and frequency (Brysbaert & New, 2009). For those words that had not been used in research with children of the same age range (asthma and neutral words), these were piloted in a primary school with 10 nine-year olds. Words were only included in the study where 100% of the pilot sample could read them. These words were also cross referenced using an encyclopaedia of words which has been rigorously tested for reading level (Dale & O'Rourke, 1981). This was to ensure that the words used were readable for the school level of the youngest participants.

A pool of 266 neutral, general negative emotion, anxiety and asthma words were subsequently rated in terms of both their relatedness to asthma and anxiety, and their emotionality by 15 trainee clinical psychologists in order to generate the final list of 96 words. Asthma and anxiety words were only included if they were deemed to be significantly different from each other. Neutral words were included if they were given an emotionality rating of "0" from all raters. The final list of general negative emotion words was also rated to be similar in terms of their emotional content to the anxiety symptom words.

Inhaler use

To measure use of the reliever inhaler, participants were given a self-report written diary (cf., Main, Moss-Morris, Booth, Kaptein, & Kolbe, 2003). Participants were asked to complete this for a period of 2 weeks following the dot probe task and completion of the other measures. They were asked to indicate how many puffs of their blue (reliever) inhaler they had each day. For each participant, a score was derived by summing the total amount of single uses of the inhaler which was used to provide an indication of the reliever inhaler frequency.

Parental anxiety

The main caregiver for each participant completed the Trait scale from the State-Trait anxiety inventory (STAI-Y2; Spielberger, Gorsuch, & Lushane, 1970). State and trait anxiety are tested with separate questionnaires, each comprised of 20 items. Trait anxiety is stable and relates to personality and this scale has shown to have high levels of internal consistency; when measured across a sample of students, working adults and military employees, the median correlation coefficient was shown to be 0.90 (Spielberger & Sydeman, 1994). The STAI-Y2 also showed high internal consistency within this sample with $\alpha = 0.93$.

Procedure

For the group with asthma, all potential participants were approached by the respiratory team at their current asthma clinic. This involved providing information about the research outlining the details and aims of the study and including details about participation being voluntary and confidential. Parental and child consent and/or child assent, where applicable were subsequently gained prior to participation.

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The data were collected by the first author by conducting home visits. Participants completed the dot probe in a quiet room of their choice with the experimenter present. The participants received computer-generated instructions that informed them of the task. The instructions explained that they would see two words (one above the other) appear on the screen, and they were asked to press either the "I" or the "M" key depending on which word the dot replaced on the screen. They were also instructed to do this as quickly and accurately as possible. There were 10 practice trials, with the option to practise these trials again if necessary. Once the participants started the experimental trials, the task took 10 minutes to complete. After the participants had completed the dot probe, the main caregivers filled out the STAI-Y2. The experimenter then left the participants with the asthma diary to complete daily for the following 2 weeks and post back in a provided stamped, addressed envelope. This procedure was explained to both the children and the caregivers to ensure understanding and maximise return of the diaries. Verbal consent was gained to follow up with a reminder phone call if this had not been received after 3 weeks.

For the control group, children and caregivers were given information about the research from their school and asked to indicate if they would be interested in taking part. Following this interest, their consent and assent was gained and the main caregiver was asked to fill out the STAI-Y2. Upon receiving this, the experimenter visited the school to conduct the dot probe with the consenting participants who met the inclusion criteria. This was completed in a quiet room with the same procedure as the experimental group, excluding the use of the asthma diary.

Data screening

Data reduction and analysis

All analyses were conducted using SPSS 19.0. In line with previous child attentional bias studies, and in order to remove outliers, the data for each participant were screened and those response times of 200 ms or less, or 1500 ms or more were removed (Hunt et al., 2007). Incorrect responses were also removed. Outliers and incorrect responses accounted for 2% (65 in total) of the total number of responses across all participants. Histograms and Probability-Probability plots were visually inspected to assess the normality of the data and skewness and kurtosis values were converted into *z*-scores to quantify normality. Examinations of the *z*-scores showed that all variables apart from inhaler use were normally distributed. The scores for inhaler use were therefore transformed using log transformation to provide a normal distribution to allow for parametric analyses.

To investigate effects of group and word type, the mean reaction times for each participant were used to calculate an attentional bias score for each type of threat word, using a previously established formula which is common across dot probe research (cf., Mogg, Bradley, Millar, & White, 1995). This was then used to investigate the effect of group (asthma, no asthma) and word type (asthma, anxiety, general negative) on attentional bias.

$$\text{Attentional bias} = 1/2((\text{UpLn} - \text{UpUn}) + (\text{LpUn} - \text{LpLn}))$$

where U = upper position, L = lower position, p = probe, n = negative (or threat) word. Therefore, for example, UpLn equates to the mean score of when the probe is in the upper position and the threat word is in the lower position. A positive score denotes an attentional bias towards that category of word and a negative score denotes a bias of attention away from the type of word.

To investigate whether attentional bias was due to vigilance or difficulty in disengaging from the cues, a method originally proposed by Koster, Crombez, Verschuere, and De Houwer (2004) was employed. Here, the mean reaction time from the neutral–neutral trials was compared to the mean reaction time from the trials where the dot appeared at the location of the threat word (congruent), and where it appeared in the alternative location (incongruent). If attentional bias is due to vigilance, it would be expected that reaction times would be quicker on congruent trials

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compared to neutral–neutral trials. Alternatively, if the attentional bias is due to difficulties disengaging from the stimuli, it would be expected that reaction times would be slower on incongruent trials compared to neutral–neutral. Correlational analyses using Pearson's product-moment correlation coefficients were also conducted to investigate the relationships between the self-reported individual differences and the indices of attentional bias. Due to multiple correlations being made, the alpha level was adjusted to 0.01 to allow for a more stringent assessment of significance.

RESULTS

Bias for asthma, anxiety and emotion

The asthma group had a higher attentional bias score for asthma words (M = 30.20) compared to those without asthma (M = −6.83) (Table 1). Mean response latencies were analysed using the previously mentioned formula to take into account location of the threat word and probe. To test the first hypothesis, a mixed ANOVA was carried out to measure the effect of group (asthma, no asthma) and word type (asthma, physical anxiety, general negative emotion) on attentional bias. The interaction between group and word type on bias scores was not significant $F(2,68) = 0.90$, $p = .41$, $d = 0.33$, indicating that overall bias scores did not change depending on group and word type. In addition, there was no effect of word type $F(2,68) = 0.70$, $p = .50$, $d = 0.29$ indicating that overall, word type did not affect bias score. There was a significant main effect of group $F(1,34) = 4.87$, $p = .34$, $d = 0.76$ indicating that bias scores for asthma and asthma-free groups differed. Bias scores for asthma words differed significantly between groups $t(34) = 2.88$, $p = .01$, $d = 0.99$; however, bias scores did not differ between groups for either anxiety words $t(34) = 0.30$, $p = .77$, $d = 0.10$ or general negative words $t(34) = 0.53$, $p = .60$, $d = 0.18$.

Bias scores were compared to 0 within the asthma group using a one sample t-test. This showed that children with asthma had an increased bias for asthma words $t(17) = 2.94$, $p = .01$, $d = 0.71$, but not anxiety $t(17) = 0.49$, $p = .63$, $d = 0.02$ or general negative words $t(17) = 0.10$, $p = .92$, $d = 0.01$. In general attention bias

Table 1. *Means of participant characteristics and attentional bias indices by asthma group*

	Asthma group (n = 18)	*Asthma-free group (n = 18)*
Mean age in months (SD)	129.89 (13.90)	128.28 (11.20)
Gender (n; %)		
Males	14; 78.78	14; 78.78
Females	4; 22.22	4; 22.22
Child ethnicity (n; %)		
White British	17; 94.44	17; 94.44
Other	1; 5.56	1; 5.56
Parent ethnicity (n; %)		
White British	17; 94.44	16; 88.90
Other	1; 5.56	2; 11.10
Mean amount of removed data (SD)	1.94 (1.86)	1.67 (2.00)
Mean asthma words response latency (SD)	609.77 (160.11)	577.71 (168.56)
Mean anxiety words response latency (SD)	620.24 (131.95)	565.08 (155.88)
Mean gen. neg. emotion words response latency (SD)	632.75 (170.13)	575.48 (155.41)
Mean parent STAI-Y2 (SD)	38.94 (10.24)	30.28 (6.56)
Mean asthma bias (SD)	30.20 (43.57)	−6.83 (32.83)
Mean anxiety bias (SD)	5.71 (49.36)	0.19 (61.79)
Mean general negative emotion bias (SD)	1.39 (60.98)	−8.26 (47.02)

Gen. neg. = general negative; STAI-Y2 = State-Trait Anxiety Inventory, trait form.

literature, a bias score of 5–10 ms denotes the lower bound used as a cut-off for attentional bias (Eldar et al., 2012). Congruent with this, the children without asthma showed no attentional bias for any word group.

Vigilance/disengagement

Vigilance or disengagement was analysed for asthma words, in the asthma group. Mean reaction time on congruent trials (608.24 ms, SD = 160.89) was not significantly different from the mean neutral reaction time (631.53 ms, SD = 151.57), $t(17) = -1.31$, $p = .21$, $d = 0.14$. Additionally, the mean reaction time on incongruent trials (639.98 ms, SD = 147.40) was also not significantly different from the neutral trials $t(17) = 0.53$, $p = .60$, $d = 0.05$.

Caregiver anxiety and bias scores

Caregivers of children with asthma were significantly more anxious than those of children without asthma $t(34) = 3.02$, $p = .01$, $d = 1.04$. There was also a significant positive correlation between parental STAI-Y2 scores and asthma attentional bias in the asthma group ($r = .57$, $p = .01$), indicating that increased vigilance for asthma words was associated with greater caregiver anxiety. No other bias scores were significantly associated with caregiver anxiety in the asthma group. There were no significant correlations between caregiver anxiety and any category of bias scores in the group without asthma (Table 2).

Inhaler use and bias scores

Pearson's correlational analyses revealed no significant correlation between inhaler use and any of the bias scores. Furthermore, caregiver anxiety was not significantly related to inhaler use.

DISCUSSION

The aim of this study was to test if children with asthma selectively attend to asthma or anxiety-related cues. It was hypothesised that this group of participants would show a bias for asthma and anxiety cues over participants without a diagnosis of asthma but that they would not show a bias towards general negative emotion words. Given the suggested link between childhood anxiety and parental anxiety and problems with overuse of medication, the secondary aim was to investigate a relationship between attentional bias, caregiver anxiety and inhaler use.

The first hypothesis was partially supported; despite a non-significant interaction, the results indicate an asthma-specific bias in children with asthma. However, from these results, it is difficult to clearly infer if this bias is specific only to children with asthma due to a lack of an interaction effect. In addition, neither the asthma nor asthma-free group selectively attended to the anxiety-related words at a significant level. It was also shown that although the asthma group showed a bias towards asthma-related words, they did not selectively attend towards general negative emotion words, demonstrating that their bias could not be explained by a general vigilance to emotional stimuli. The indication of an attentional bias in the asthma group is similar to

Table 2. *Correlations among attentional bias and questionnaire variables in the asthma group*

	1	*2*	*3*	*4*	*5*
1. Asthma AB	–	–	–	–	–
2. Anxiety AB	−0.08	–	–	–	–
3. Gen. Neg. Emot. AB	−0.48*	−02D; 0.15	–	–	–
4. Caregiver STAI-Y2	0.57**	0.11	−02D; 0.42	–	–
5. Inhaler use	−0.10	−02D; 0.11	0.21	−02D; 0.16	–

AB = attentional bias; Gen. Neg. Emot. = General negative emotion; STAI-Y2 = State Trait Anxiety Inventory, Trait Form.
*$p \leq .05$; **$p \leq .01$.

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findings from previous adult research (Jessop et al., 2004). Here, Jessop et al. (2004) concluded that selective attention to asthma cues denotes an "emotional representation" of the illness which could not be measured by self-report mood-based questionnaires. They further found that this was related to low adherence to preventative medication, and a nearly significant association with high adherence to medication regime. They suggested that having an emotional representation of the illness could be either a motivating factor to adhere to treatment regimes, or a factor which could interfere with adherence. De Peuter et al. (2007) also found that high vigilance to asthma words in the asthma group was related to high negative affectivity; a factor which has been related to anxiety. Generally, selective attention is proposed as an adaptive cognitive function manifested due to a perception of anxiety and threat (Cisler & Koster, 2010). Those individuals with asthma implicitly detected threat in asthma-related information, suggesting a concern surrounding the illness which is emotionally entrenched. However, the lack of a significant interaction within these findings is a limitation of the study, as this reduces the ability to assume that the bias is specific to the asthma group.

Although there were group differences in bias for asthma words between groups, there was no significant relationship with the measured reliever inhaler use. If bias to asthma cues is a problem or maintenance factor within the illness, it would be expected that this would be related to negative health-related behaviours. The hypothesis within this research was that negative health-related behaviours would be reflected by overuse of the reliever inhaler, which could be classed as a safety behaviour. However, this assumption is not straightforward as unlike other anxiety-driven safety behaviours, those with asthma do require a certain level of vigilance in order to maintain good asthma management. Vigilance should not be completely discouraged within asthma populations as this could result in missing key symptoms and could have serious health-related implications. This complexity of balancing the correct level of vigilance (and inhaler use) may help to explain the lack of association found between inhaler use and asthma bias. Adding to this, the sample size was small for correlational analyses and therefore underpowered for these comparisons and the use of a self-report written diary within the research may have reduced validity here which may be reflected in the lack of significant correlations. It may also have been helpful to measure adherence to preventer medication as within the study by Jessop et al. (2004); this would have perhaps been a more specific capture of health-related behaviours due to the prescribed nature of the dosage. However, as the research sample was taken from specialised asthma clinics and all children had a moderate to severe diagnosis of asthma, it can be assumed that the population in this study had additional problems with their illness, over and above the general asthma population. It has been stated that as many as nine out of ten patients with asthma are treated within primary care (cf., Baishnab & Karner, 2012) and it would therefore be helpful to replicate the research including both secondary and primary care managed patients (mild asthma vs. severe asthma). This would confirm if an attentional bias and therefore perceiving threat in the illness is related to severity and complexity of the health problem.

There was an absence of a significant attentional bias towards anxiety-related words in this research. It was thought that due to the higher incidence of panic-related anxiety within asthma populations (Goodwin et al., 2003), children with asthma may show an attentional bias to anxiety symptom cues which in turn may correlate to the amount they use their reliever inhaler. In terms of anxiety, the stimuli used were disorder specific, and previous research with children and adolescents has shown that attentional biases in youths can be related to specific worries (Moradi, Taghavi, Neshat Doost, Yule, & Dalgleish, 1999). It has, however, been suggested that content-specific attentional biases vary with age and clinical status as fear will increase through exposure (Hunt et al., 2007). Naturally, older individuals will have experienced more exposure to feared situations and would subsequently be more susceptible to content-specific attentional biases. An attentional bias to anxiety symptom

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stimuli may not have been demonstrated given that this research used a non-clinical (anxiety), younger child sample compared to that of Moradi et al. (1999). The anxiety-related words may also not have held adequate threat value to capture attention, or have been sufficiently associated with the actual somatic feeling of panic. The same set of anxiety threat words were developed and utilised in a previous piece of research with children with high anxiety sensitivity. Here, an attentional bias was found but not exclusively to this set of stimuli, demonstrating a non-specific emotional attentional bias (Hunt et al., 2007). It is also plausible that this population did not have sufficient levels of panic-related anxiety to demonstrate a disorder-specific attentional bias. Including a child anxiety-related self-report measure may have been helpful to clarify this and would also have shown whether or not attentional bias could be captured by conventional anxiety questionnaires which would have allowed further replication of the study by Jessop et al. (2004).

A further finding was that those in the asthma group had caregivers with significantly higher levels of anxiety, measured by the STAI-Y2 than those in the asthma-free group. It is not possible to comment upon causality here and it is important not to place too much emphasis on this due to the fact that parents of children with chronic illnesses would be expected to have higher stress levels due to the burden of the illness on the family (Cousino & Hazen, 2013). However, this finding does replicate previous research (Brook, 1991), and explanations for this finding have been that parental anxiety impacts on how well the asthma can be managed; those with severe, less well managed asthma have more anxious parents (Staudenmayer, 1981). Conversely, Cookson, Granell, Joinson, Ben-Shlomo, and Henderson (2009) found that mothers' prenatal anxiety can directly lead to their child developing asthma which would suggest that children of higher anxious mothers may be more likely to developing the illness. There is not one universal viewpoint on the relationship between parental anxiety and childhood asthma; however, a link has been established.

Furthermore, within the asthma group in this study, higher levels of parental anxiety were related to increased attentional bias for asthma-related words in the children. It is possible here that asthma severity is a contributing factor in the relationship between parental anxiety and attentional bias. By including different levels of asthma severity in further research, illness severity could be controlled for as confound. Unfortunately, within this research, all diagnoses were "moderate to severe" asthma, and so asthma severity could not be controlled for in the analyses. Alternatively, this finding could be interpreted in line with previous research investigating the relationship between parental and child anxiety. If the attentional bias to asthma words demonstrates an emotional concern surrounding the illness, then it could be suggested that this is related to anxiety at some level. Again, including a measure of child anxiety may have helped with this interpretation. Much of the research into child and parental anxiety discusses the powerful influence of modelling from caregivers, and the anxiety inducing consequence of children receiving negative information from their caregivers. Field (2006) showed that after receiving negative information about novel animals, children demonstrated an attentional bias for this animal on the dot probe task. It has also been shown that children and adolescents of caregivers with a diagnosis of posttraumatic stress disorder (PTSD) displayed an attentional bias to PTSD-related threat words compared to control participants whose parents had no diagnosis (Moradi, Neshat-Doost, Teghavi, Yule, & Dalgleish, 1999). Furthermore, adults with high levels of trait anxiety are more likely to perceive ambiguous situations as threatening (Eysenck, Mogg, May, Richards, & Mathews, 1991), and therefore perhaps higher anxious caregivers may interpret asthma indicators increasingly negatively. It has also been shown in a piece of research that parental cognitive processing of children's pain is related to parental catastrophising, but not trait anxiety (Vervoort et al., 2011). Taken into context within this research, if children are receiving negative messages about their asthma from their caregivers, this may increase their attentional

biases for asthma-related stimuli. It may be that there is another factor, related to parental anxiety which could be driving children's attentional bias. This needs to be verified in further research and could be achieved by assessing a relationship between parental variables and children's attentional bias. However, cross-sectional research is limited in clarifying the nature of such a relationship as it is difficult to determine whether parental anxiety pre-dates attentional bias, or whether they co-exist due to the severity of the condition.

It is possible that instead of a perception of threat surrounding the asthma words, participants with asthma were displaying an attentional bias due to the familiarity and frequency of exposure to such stimuli. Previous research reports that this is not the case; within the study by Jessop et al. (2004), the researchers showed that there was no significant difference between an asthma primed and non-primed group, concluding that recent encounters and contemplation about asthma stimuli did not affect attentional bias. In addition, recent trials where attention has been modified away from threat stimuli have shown positive effects on anxiety levels (Bar-Haim, Morag, & Glickman, 2011; Eldar et al., 2012; Shechner et al., 2014). Subsequently, participants also show a reduction in attentional bias to threat words. If attentional bias is related to familiarity instead of anxiety, these results would not be expected.

In terms of analysing the mechanism behind attentional bias, i.e., whether this is due to vigilance or a difficulty in disengaging from the stimuli, the results did not yield any significant differences between neutral trials and either congruent or incongruent trials. It is possible that this was due to the large variance, and small sample size of the study. Based on the mean differences, a tentative prediction could be made that attentional bias was due to vigilance to asthma words; however, further research is required to test this. This is important as understanding the mechanism behind attentional bias is crucial, particularly in clinical samples where interventions can be informed.

LIMITATIONS

One limitation of the present study was the reliance on self-report data, particularly with measuring inhaler use. Self-report asthma diaries have been subjected to criticism due to patient burden or social desirability affecting reliability (cf., Milgrom et al., 1996) though it has also been shown that inhaler diaries can be as accurate as less subjective measures (Butz, Donithan, Bollinger, Rand, & Thompson, 2005). Self-report diaries were chosen to limit access to patient notes; however, a more accurate measure could have been taking account of prescription refills of the reliever inhaler over a period of time with consent of the participants. In order to reduce participant burden and increase reliability and compliance, the diaries were as brief as possible and were fully explained to both the children and caregiver. The addition of a child self-report anxiety measure would have also improved this research, as already mentioned. This would have provided further information on the relationship between anxiety and attentional bias in children, and moreover would have perhaps provided key information on the relationship between parental and child anxiety and attentional bias.

The dot probe paradigm was chosen over other previously used measures such as the emotional Stroop paradigm, as it has been suggested that the dot probe task is the most effective in this age range for investigating attentional biases (Dalgleish et al., 2003). Within adult attentional bias research, a "vigilance-avoidance" hypothesis has been proposed where stimuli which are displayed for a prolonged latency (i.e., 1500 ms) encourage individuals to avert their attention, whereas vigilance is best captured at shorter presentation times (Mogg, Bradley, Miles, & Dixon, 2004). This may have implications for research within child populations, as it is recommended to extend the stimulus presentation time to account for less mature processing speed (Vasey & Daleiden, 1995). This "vigilance-avoidance" pattern is not yet understood in children and adolescents; however, in research with younger populations, it may be particularly useful to use subliminal presentation of stimuli to ascertain if there is a

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difference in attentional bias depending on presentation times. Additionally, to take account for less developed executive functioning, it has been suggested that including relevant assessments such as the Test of Everyday Attention for Children (Manly & Anderson, 2001) would allow for an assessment of the relationship between attentional bias and cognitive capacity (Puliafico & Kendall, 2006).

In order to enhance the reliability of the words used in this research, the participants could have been required to read all of the words after completing the dot probe. This would have ensured that all participants could read the included words thus reducing potential confounding from different reading abilities. This was not carried out within this research with the aim of reducing participant burden. A test of reading abilities was not included for the same reason. It was thought that in piloting the included words with children who had different reading levels, and cross referencing with a well utilised encyclopaedia (Dale & O'Rourke, 1981), there could be a certain amount of confidence that the children would not have significant reading-related problems with the included words.

This study is unlikely to have sufficient statistical power for detecting effects in the some of the analyses. As such, it is important to interpret these results as preliminary investigations into the subject area, and a replication of the findings with larger sample sizes would be indicated for future research.

Further research within child populations is required to confirm the causal role of attentional bias in problems with anxiety and asthma. However, it may be helpful to modify attention to perceived threatening cues; an intervention which is currently being tested with child anxiety populations (cf., Shechner et al., 2014). A clear finding from this research was the relationship between parental anxiety and attentional biases. As such, as far as possible it may be helpful to assess and implement systemic approaches to reduce parental or familial anxiety when supporting a child with complex asthma.

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