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# Sleep disturbance and insomnia in children: The relationships between children's sleeping habits, pre-sleep arousal and sleep-related attentional bias

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## ABSTRACT

Although sleep disturbances are commonly reported among children, little is understood about the processes associated with childhood insomnia. Adult models of insomnia have suggested that cognitive arousal and sleep-related attentional bias are two processes associated with insomnia. The present study aimed to investigate the relationships between children's sleeping habits, pre-sleep arousal and sleep-related attentional bias. Parents of children, aged 7-11, completed the Children's Sleep Habits Questionnaire, and children completed the Pre-sleep Arousal Scale, and a visual-dot-probe task in order to investigate whether children reported to have insomnia and children with more broadly defined 'sleep disturbance' demonstrate greater sleep-related attentional bias and report greater cognitive than somatic arousal than children without sleep disturbance. It was found that children with sleep disturbance demonstrated greater sleep-related attentional bias than children without sleep disturbance; there was no significant difference between the attentional bias scores of children with and without insomnia; children with both high sleep disturbance and insomnia reported greater cognitive than somatic arousal; there was no significant differences between the reporting of cognitive arousal by children with and without sleep disturbances; and that there was no association between attentional bias and cognitive arousal scores. Further research is needed with a clinical population.



| KEY WORDS: | ATTENTIONAL BIAS | SLEEP | DISTURBANCE | INSOMNIA | AROUSAL | CHILDREN |
|---|---|---|---|---|---|---|

## Introduction

Sleep problems in children are very common (Stores, 2009) where approximately 25% experience some type of sleep problem at some point during their childhood (Owens, 2008). Several studies have provided evidence suggesting high prevalence rates of parent- and child-reported sleep problems within large samples of healthy children. For example, it was found that around 31% of 6 to 13 year olds complain of problems initiating and maintaining sleep (Spruyt, O'Brien, Cluydts, Verleye, & Ferri, 2005). Sleep disturbance, and especially difficulty sleeping, is troublesome for the child and their family at the time of insomnia; it can affect neurobehavioural functioning, learning, academic performance, behaviour, temperament and mood (Sadeh, 2007). Thus, the investigation of the potential processes contributing to the initiation and maintenance of insomnia, in children, is important so that effective interventions and treatments can be developed. A variety of processes have been associated with sleep disturbance in adults across different models, including behavioural (Bootzin, 1972), cognitive (Espie, 2002; Harvey, 2002), neurocognitive (Perlis, Smith, & Pigeon, 2005), neurobiological (Buysse, Germain, Hall, Monk & Nofzinger, 2011) and cognitive-behavioural (Morin, 1993). Although sleep disturbance is commonly reported among children, little is understood about the processes associated with insomnia in children (Gregory, Noone, Eley, & Harvey, 2010). Childhood insomnia has been understood more from a behavioural perspective where there is good evidence that behavioural factors play a role in the initiation and maintenance of childhood sleep difficulties (Blampied & France, 1993; France & Blampied, 1999; Wiggs, 2009); and that behaviour therapy can be used as an effective form of treatment (Owens, Palermo, & Rosen, 2002; Owens, France, & Wiggs, 1999). However, the effective use of behaviour therapy does not imply that childhood insomnia is behavioural in origin or that it is maintained by behavioural factors (Wiggs, 2009); thus, other processes associated with childhood insomnia need to be addressed. There is a small, but growing, literature suggesting that cognitions could also be associated with childhood insomnia (Gregory, Willis, Wiggs, & Harvey, 2008), indicating a need to further understand the role that cognitive processes play in the development and maintenance of childhood insomnia.

Insomnia as a disorder is defined as difficulties in initiating and maintaining sleep and/or non-restorative sleep accompanied by decreased daytime functioning (American Academy of Sleep Medicine, AASM, 2005). According to Espie's (2002) psychobiological inhibition model, adult insomnia is viewed as arising from inhibition of de-arousal processes, associated with normal sleep, where automaticity and plasticity are weakened by cognitive-affective processes that inhibit both mental and physiological de-arousal, thus inhibiting sleep initiation and maintenance (Espie, 2002; Taylor, Espie & White, 2003). The psychobiological inhibition model emphasises the role of selective attention in the development and maintenance of insomnia where psychological and physiological stress is proposed to lead to selective attention toward stressors, and inhibition of the de-arousal that accompanies normal sleep; this arousal may then result in selective attention toward sleep-related cues and increased intention and effort to sleep which, in turn, further inhibits de-arousal (Buysse et al. 2011). Harvey's (2002) cognitive model proposes that adults, suffering from insomnia, tend to be excessively worried about getting enough sleep and about the impact of sleep disturbance on health and daytime

functioning. This triggers autonomic arousal and emotional distress, creating an anxious state which, in turn, triggers selective attention towards and monitoring of internal and external sleep-related threat cues (Harvey, 2002). It is suggested that the anxious state, together with the attentional processes it triggers, results in the individual misjudging how much sleep they obtained and how much the sleep disturbance affected their daytime functioning (Harvey, 2002).

These models of insomnia involve the cognitive phenomenon known as attentional bias. Attentional bias refers to an individual's cognitive tendency to focus on stimuli that are salient (Marchetti, Biello, Broomfield, MacMahon, & Espie, 2006). According to Beck's (1976) cognitive theory, attention is biased towards disorder-specific information; individuals with a particular disorder are sensitive to and preoccupied with stimuli that are related to that disorder (Williams, Mathews, & MacLeod, 1996). One component of Beck's theory, the content-specificity hypothesis, suggests that this tendency to attend to particular information over others is due to its emotional relevance (Clark & Beck, 1989). Support has been found implicating attentional bias in the development and maintenance of a wide range of anxiety-related psychological disorders and concerns; however, little comparable research, either at the clinical pole or along the sleep-disturbance continuum, has been carried out on sleep-related attentional bias (Jones, Macphee, Broomfield, Jones, & Espie, 2005), especially not in children. Nonetheless, research that has been carried out in this area has provided evidence for the presence of an attentional bias toward sleep-related stimuli in adults experiencing sleep disturbance, especially insomnia. This suggests that attentional bias is one cognitive process associated with insomnia (Jansson-Frojmark, Bremas, & Kjellen, 2012).

Throughout the sleep literature, attentional bias has been predominantly measured using three main tasks: the induced-change-blindness flicker, Stroop and visual-dot-probe tasks. In the induced-change-blindness flicker task, one feature (sleep or neutral), of a visual scene, is changed between successive presentations until the change is detected (Jones et al., 2005). Change-detection latency, as measured by the number of flickers it takes for the change to be detected, is explained by object salience; individuals with insomnia tend to detect a sleep-related change faster than a neutral change, providing evidence for attentional bias (Marchetti et al., 2006). Jones et al. (2005) investigated sleep-related attentional bias in non-clinical individuals that were divided into good, moderate and poor sleepers, using the flicker task. It was found that only poor sleepers, who detected the sleep-related change faster than the neutral change, showed attentional bias towards a highly representative bedroom object whereas, good sleepers detected the neutral change significantly faster. Although this study suggests that attentional bias towards salient sleep stimuli is associated with the development and maintenance of insomnia, it had its limitations. It only used a single sleep-related and neutral change, meaning that the findings and conclusions may not generalise to other bedroom and neutral stimuli. In addition, a non-clinical sample was used whereby the classification of poor sleepers, as suffering from insomnia, was concluded solely based on scores from the Pittsburgh Sleep Quality Index.

The modified Stroop task (Stroop, 1935) involves the display of threatening and neutral words in various colours, on a screen, whereby the participant is required to report the colour while ignoring the semantic content of the word (Cisler, Bacon, &

Williams, 2009). The task measures the degree to which participants are slower in responding to the colour of the sleep-related words than to the neutral words (Spiegelhalder et al., 2010). Longer response latency is thought to indicate increased attentional bias due to automatic processing of word meaning interfering with colour naming (Taylor et al., 2003). Taylor et al. (2003) measured sleep-related attentional bias, using the Stroop task, in a cancer population who had acute sleep disturbance and persistent insomnia. They found that only the persistent insomnia group exhibited attentional bias towards sleep-related words, suggesting that attentional bias might be associated with the transition from acute to persistent insomnia. However, the cancer population studied raises questions about the generalisability of these findings; and the lack of a control group, without a medical problem, means that the findings should be interpreted with caution. Whether the Stoop task measures increased attention or whether it indicates the impact of heightened arousal inhibiting information processing, in the presence of salient stimuli, is questioned (Marchetti et al., 2006).

The visual-dot-probe task, put forward by MacLeod, Mathews & Tata (1986) overcomes this problem of the Stroop task as it is a more direct measure of attentional bias, reflecting the scanning of the visual field (Spiegelhalder et al., 2010). The task involves two stimuli, either words or pictures, being presented together on a screen; one stimulus being sleep-related and the other neutral. Following a brief presentation, these stimuli would disappear and a dot probe would appear in the location of one of the previously presented stimuli. The participant is required to detect the probe as soon as possible (Cisler et al., 2009). The analysis of the impact of pairs of stimuli on probe detection latencies, in two separate locations, allows for the conclusion of whether visual attention shifted towards or away from such stimuli (Marchetti et al., 2006). MacMahon, Broomfield & Espie (2006) employed the visual-dot-probe task in order to investigate whether individuals with primary insomnia show an attentional bias towards sleep-related words in comparison to individuals with delayed sleep phase syndrome (a biologically based sleep disorder understood to be maintained without a contribution from cognitive biases) as well as a control group of good sleepers. A small, but significant, sleep-related attentional bias was found in the primary insomnia group, suggesting an association between attentional bias towards sleep-related stimuli and insomnia. Using word-based stimuli may reduce attentional bias because of the lack of emotional salience; thus, it is suggested that pictorial stimuli are used to increase the saliency of stimuli (MacMahon et al., 2006). Jansson-Frojmark et al. (2012), using pictorial stimuli, found that adults with insomnia displayed an attentional bias towards threatening, sleep-related pictures compared to normal sleepers. However, one problem with this study was that the pictorial stimuli were not validated prior to the start of the experiment but was alternatively assessed, qualitatively, by the researchers. In addition, priming effects may have occurred due to the fact that self-report measures were completed before the task which could have led to greater attentional bias. One methodological limitation of previous research, using the visual-dot-probe task, is that there was usually a large difference between sleep and neutral stimuli, suggesting decreased ecological validity. For example, MacMahon et al. (2006) included sleep-related words, such as pillow and naps, versus neutral words, such as pear and money. Thus to increase the findings ecological validity, it is suggested that there is a smaller difference between the relationship between sleep and neutral stimuli (Jansson-Frojmark et al., 2012).

A recent study that investigated sleep-related attentional bias in children was carried out by Ellis, Thomson, Gregory & Sterr (2013). They used the Stroop task, and a tired state induction, to examine whether children, whose parents suffer from insomnia, show an attentional bias towards sleep-related stimuli. A significant group difference was found; children of parents with insomnia displayed greater attentional bias for sleep-related words compared to controls, suggesting children, whose parents have insomnia, are vulnerable for insomnia themselves. However, longitudinal research is needed to establish whether children, who display this attentional bias, actually go on to develop insomnia. Although, this study did not examine insomnia in children directly, it is a starting point for the understanding of the processes involved in the development and maintenance of childhood insomnia.

It is suggested that attentional bias for sleep-related stimuli can lead to the development and maintenance of insomnia through two processes: by promoting sleep preoccupation and by driving heightened sleep effort (Jones et al., 2005). These processes are thought to prevent cognitive and somatic de-arousal, inhibiting the recovery of normal sleep (Espie, 2002). Pre-sleep arousal refers to physiological (such as heart beating rapidly) and mental (such as worrying about not falling asleep) processes, which are known to be related to adult insomnia (Gregory et al., 2008). Espie's (2002) psychobiological inhibition model and Harvey's (2002) cognitive model of insomnia both suggest that cognitive de-arousal appear central to insomnia. This is supported by Lichstein & Rosenthal (1980) who found that cognitive arousal was ten times more likely than somatic arousal to be reported as the main factor associated with the development and maintenance of insomnia. Individuals with insomnia experience excessive pre-sleep cognitive activity; they report intrusive thinking where they appear to be mainly concerned about sleeplessness and its consequences (Espie, 2002). Some of the most useful treatments for adult insomnia work by trying to change these thoughts that appear to be preventing sleep. However, there appears to be little understanding on whether children's thoughts affect their sleep patterns; thus further research is needed on the relationship between children's thoughts and their sleep in order to develop treatments to help children with insomnia. Recent research that has investigated children (Gregory et al., 2008) found that cognitive, over somatic, arousal appears to be associated with children's sleep disturbances.

Studies (Fisher & Wilson, 1987; Simonds & Parraga, 1982) that have examined children's sleeping habits, in order to define sleep disturbance, and specifically insomnia, in children have largely relied on parent-report measures. Although the child may inform the parent to a sleep problem, sleep disturbance is often identified by the parent who is the one to assign significance to it and to define it for a clinician (Owens et al., 2002). It is important to utilise parents to understand the potential origins of, and factors maintaining, sleep disturbance because children are often not aware of nocturnal events that can disturb sleep (Moturi & Avis, 2010). With child-reports, there is the possibility that children may respond inaccurately. For example, children may tend to answer "sometimes", reflecting 2-4 times per week, if the behaviour occurred at all, thus falsely increasing the score on those items; and those items that require an estimation of time may be incorrectly perceived by children (Owens, Spirito, McGuinn, & Nobile, 2000). However, some sleep habits may be perceived more accurately by children because parents may be unaware of the

behaviour or may not perceive the behaviour as a presenting problem (Owens et al., 2000). For example, it has been found that parents of older children, in particular, may not always be aware of any difficulties initiating and maintaining sleep (Owens, Spirito, & McGuinn, 2000; Owens et al., 2000). Insomnia is a subjective disorder (Wilson & Nutt, 2007), thus objective measures of sleep, such as actigraphy, are not necessary to define childhood insomnia. In addition, it has been found that parental report is relatively accurate for defining sleep disturbances in children when compared to objective data (Marcus et al., 1992).

Adult data, models, and treatments cannot be assumed to apply to children as well because of developmental differences (Gregory et al., 2008). Therefore, the factors involved in the development and maintenance of childhood insomnia need to be investigated as they may be different compared to adults. The present study investigated the relationships between children's sleeping habits, pre-sleep arousal and sleep-related attentional bias. Although the Stroop task is the most commonly used task to measure attentional bias, and has been used in many studies investigating attentional bias, the present study employed the visual-dot-probe task. This is because the latter is a more direct measure of attention allocation, reflecting the scanning of the visual field (Spiegelhalder et al., 2010) and because pictures can be used which have greater ecological value compared to words. In addition, the reading skills of children differ and you can't be sure if the child can read, and grasp, the words being presented; thus pictures are preferred over words. As it has been concluded that parent-reports of children's sleep habits are sufficiently accurate for research and clinical use (Blampied & France, 1993), the Chilren's Sleep Habits Questionnaire (Owens et al., 2000) was employed to measure childhood insomnia as this parent-report is a useful and widely used sleep screening instrument to outline sleep habits, and identify problematic sleep domains, in school-aged children. Child-reports were not employed because it could not be guaranteed that parents would not assist their children and influence their responses. In addition, it was not expected to have a high response rate and obtaining child-reports may have reduced the response rate expected from parents. Children's pre-sleep cognitive and somatic arousal was measured using the Pre-Sleep Arousal Scale (PSAS) (Nicassio, Mendlowitx, Fussell, & Petras, 1985). The PSAS was used because it has been shown to be associated with childhood insomnia (Gregory et al., 2008). In addition insomnia is a subjective complaint; and as insomnia was measured based on parent-report, using the PSAS was a method of collecting children's self-reported sleep problems and seeing whether they are associated with attentional bias.

The present study aimed to investigate (1) whether children reported to have insomnia demonstrate greater attentional bias than children without insomnia; (2) whether children reported to have insomnia report greater cognitive than somatic arousal levels; (3) whether children reported to have insomnia report greater cognitive arousal than children without insomnia; and (4) whether there is an association between attentional bias and pre-sleep cognitive arousal. Based on the adult literature, it was hypothesised that (1) children with insomnia would have a higher tendency to selectively attend to sleep-related stimuli, demonstrating greater attentional bias, than children without insomnia; (2) children with insomnia would report greater cognitive than somatic arousal levels; (3) children with insomnia would report greater cognitive arousal than children without insomnia; and (4) that there

would be a positive association between attentional bias and pre-sleep cognitive arousal.

## Method

### *Participants*

The present study focused on a non-clinical, opportunity sample of children aged 7 to 11 years old; this is because research suggests that this is around the youngest age at which children can complete self-reports about their own symptoms (Merrell, McClun, Kempf, & Lund, 2002). Upon ethical approval from Oxford Brookes University, three junior schools in Buckinghamshire and Berkshire, UK, were approached. Following permission from the Headteachers, to carry out the present study in their schools and on their pupils, piloted participation information sheets for parents and children, a consent form and questionnaire were sent out to parents of children in years 3 to 6. There were no exclusion criteria apart from age. Around 400 information and questionnaire packets were sent home to parents, by the schools; thus a specific response rate cannot be determined. A total of 53 children (26 females and 27 males), with a mean age of 8.75 years (SD=1.12), and their parents, across the three schools, consented to participate.

### *Design*

A between subjects design was employed, with the primary independent variable being sleep disturbance (insomnia versus no insomnia). The main dependent variable was attentional bias score as measured by response latency to the dot-probe on the visual-dot-probe task. A second dependent variable was pre-sleep arousal as measured by the cognitive and somatic arousal scores on the PSAS.

### *Measures*

#### *Children's Sleep Habits Questionnaire (CSHQ)*

Sleep disturbances were examined using the abbreviated version of the CSHQ (see appendix A), as used by Gregory et al. (2008). This retrospective parent-report measure, consisting of 33 items, includes items relating to a number of sleep domains in children such as bedtime behaviour, sleep onset, sleep duration, anxiety around sleep, and behaviour occurring during sleep. Parents are asked to recall their child's sleep behaviours occurring over a recent, typical week and rate on a three-point scale (1=rarely to 3=usually) how often the sleep behaviour occurred. Scores can range from 31 to 97, respectively; higher scores indicate greater overall sleep disturbance and a score of more than 41 has been established as a cut off indicative of clinically significant sleep disturbance (Owens et al., 2000). Whilst there are 8 sub-scale scores which can also be derived ('bedtime resistance'; 'sleep onset delay'; 'sleep duration'; 'sleep anxiety'; 'night wakings'; 'parasomnias'; 'sleep disordered breathing'; 'daytime sleepiness'), it should be noted that sub-scores are not intended to be diagnostic or to define the underlying etiology of the presenting sleep symptoms. As the total and sub-scale scores of the CSHQ are not specific nor diagnostic, whether the child had insomnia or not was assessed using items in the

CSHQ that focused on insomnia ('child falls asleep within 20 minutes'; 'child needs parent in the room to fall asleep'; 'child is afraid of sleeping alone'; 'child moves to someone else's bed during the night'; 'child awakes once during the night'; and 'child awakes more than once during the night'). These items were chosen based on what Gregory et al. (2008) focused on in their study, as well as two additional items that focused on arousal related to sleep. Scores on this insomnia sub-scale can range from 6 to 18, respectively; it was decided that children would be classified as having insomnia when their total score was 10 or above because this was above half of the potential total score that could be obtained.

*Pre-sleep Arousal Scale (PSAS)*

Pre-sleep arousal was examined using the PSAS (see appendix B) which is a 16-item self-report questionnaire rated on a five-point scale (1=not at all to 5=extremely), consisting of items reflecting somatic arousal (such as heart racing, upset tummy, tense muscles) and cognitive arousal (such as worry about not falling asleep and being mentally alert). Two subscale scores are derived; one for pre-sleep cognitive arousal and one for pre-sleep somatic arousal. A previously used child version of the PSAS was used (Gregory et al., 2008) so that the items would be better explained and understood by children. Modifications from the adult version included some minor word changes and explanation of terms.

*Visual-dot-probe task*

The visual-dot-probe task was administered on a Dell computer, using the software SuperLab 4.5, to measure attentional bias. The task involved five practice and 30 experimental trials, consisting of a fixation cross appearing in the center of the screen for 500 milliseconds, followed by two pictures (see appendix C) being presented simultaneously, for 750 milliseconds, at the top and bottom of the screen. Upon disappearance of the pictures, a probe (a black dot) appeared in the same spatial location as one of the pictures previously presented; this remained on the screen until a response was made. The participants had to indicate, as quickly as possible, the location of the dot-probe using designated buttons on the computer's keyboard ('t' for upper location or 'v' for lower location). Half of the trials contained a sleep-related picture with the constraint that it would always be paired with a neutral picture, resulting in 15 pairs of sleep-neutral and 15 pairs of neutral-neutral pictures. The presentation of the pairs of pictures, as well as the order of presentation for each participant, was randomised to ensure that order effects did not confound the results. The relative positions of each pair of pictures and the dot-probe were also randomised within the experiment. The sets of sleep-related (bedrooms and bathrooms) and neutral (kitchens, living rooms, and dining rooms) were selected based on the types of stimuli used in Spiegelhalder, Espie, Nissen, & Riemann (2008) study; and to overcome limitations of previous research where there was a large difference between sleep and neutral stimuli, decreasing the ecological validity of the findings. To further increase ecological validity, the pictures depicted children in everyday situations, allowing participants to relate to the stimuli. Compared to the stimuli used by Spiegelhalder et al. (2008), bathrooms were included in the sleep-related stimuli because they depicted children in their pyjamas, brushing their teeth, thus preparing for bed. To ensure that the bathroom pictures were related to sleep, and that the remaining pictures were appropriate, the stimuli were piloted on a

separate sample of children aged 7 to 11 years; children's subsequent feedback suggested the stimuli were appropriately assigned to either the sleep-related or neutral conditions. Stimuli were full colour photographs taken in natural daylight. The pictures were resized to the same dimensions (640 x 480 pixels) and matched in terms of similar qualitative aspects (lighting and background), type of everyday situation, age and gender. For each participant, attentional bias scores were calculated using the following equation, where RT is the reaction time, S is the sleep-related picture, D is the dot-probe, T is the top of the screen and B is the bottom of the screen (Spiegelhalder et al., 2010):

*Attentional bias score = mean(RT(ST/DB),RT(SB/DT)) - mean(RT(ST/DT),RT(SB/DB))*

For example, RT(ST/DB) refers to the reaction times of those trials whereby the sleep-related picture was presented at the top of the screen and the dot-probe was presented at the bottom of the screen. Positive attentional bias scores indicate awareness for sleep-related stimuli.

*Procedure*

As described previously, three junior schools were contacted; with their permission information about the present study, a consent form and the CSHQ were sent home to parents. Parents who wished to participate were required to complete and return the consent form and questionnaire. As well as written informed consent from the parents, assent was obtained from the child at the time of testing. The schools and the researcher organised dates to carry out the experiment, which would cause the least disruption to the children's school day; it was scheduled that the children would be seen individually for a period of approximately 15 minutes to complete both the visual-dot-probe task and the PSAS. The experiment was carried out in the morning between 9:00 and 12:00 in an unoccupied, quiet and well-lit room. Verbal standardised instructions on the task were provided, as well as on-screen written instructions. Once participants indicated that they understood what was required of them, and assented to participate, they began the practice trials, in order to familiarise themselves with the task, followed by the experimental trials. During the task, the experimenter was as quiet as possible and looked away from the screen and participant. The PSAS was read to the participants by the experimenter to ensure that they had a greater understanding of what was being asked; the experimenter noted down the participants' responses. The order of completing the PSAS and the visual-dot-probe task were balanced in order to prevent priming effects. Upon completion of the experiment, the participants were debriefed on the aims and purposes of the research. During the analysis, the participants were classified into two groups (insomnia or no insomnia), as indicated by the scores on the CSHQ, after the data was collected; this avoided experimenter bias.

## Results

*Preliminary analysis*

Participants were void if any data was missing from a single trial, leading to their data being excluded from the analyses; this meant that the total number of

participants with data used was 52. Although the present study did not focus exclusively on sleep disturbance in general, it was of interest to investigate the relationships between sleep-related attentional bias and pre-sleep arousal in children with sleep disturbances in general. Therefore, based on the total CSHQ score, children were classified as having high sleep disturbance when their scores were 41 or above or as having low sleep disturbance when their scores were below 41 (Owens et al., 2000). Table 1 shows the total number of participants, including the number of males and females, in both the high and low sleep disturbance group. Children were classified into the insomnia group when their total score was 10 or above or children were classified into the no insomnia group when their score was below 10. The top 11.5% of participants had a score of 10 or above and, based on their total CSHQ score, they were all indicative of high sleep disturbance. Table 1 shows the total number of participants, including the number of males and females, in both the insomnia and no insomnia group.

Table 1. The composition of the high and low sleep disturbance groups, and the insomnia and no insomnia groups.

| | **Number of Participants** | **Number of Males** | **Number of Females** |
|---|---|---|---|
| **High Sleep Disturbance** | 22 | 11 | 11 |
| **Low Sleep Disturbance** | 30 | 16 | 14 |
| **Insomnia** | 6 | 4 | 2 |
| **No Insomnia** | 46 | 23 | 23 |

Kolmogorov-Smirnov's test indicated that scores were not normally distributed for certain variables. For the low sleep disturbance group the somatic arousal and attentional bias scores were significantly non-normal; however, the cognitive arousal score was significantly normal. For the high sleep disturbance group the attentional bias score was significantly non-normal; however, the cognitive and somatic arousal scores were significantly normal. For the insomnia group, the attentional bias score, and the cognitive and somatic arousal scores were significantly normal. For the no insomnia group, the attentional bias and somatic arousal score were significantly non-normal; however, the cognitive arousal score was significantly normal. Therefore, between and within group differences, and the correlation, were analysed using either parametric or non-parametric tests. Statistical thresholds were at $P<0.05$ (one-tailed). Where parametric tests were employed, Levene's and Mauchley's tests indicated that homogeneity and sphericity assumptions were not violated.

As shown in table 2, on average, children classified as having high sleep disturbance had a later bed and wake time; fewer hours of sleep and a shorter night waking duration than children in the low sleep disturbance group. As shown in table 3, on average, children classified into the insomnia group had a later bed and wake time; fewer hours sleep and a longer night waking duration than children classified into the no insomnia group.

Table 2. Means and standard deviations of children's sleep habits in the high and low sleep disturbance groups.

| | **Age (years)** | **Child's Bedtime (analogue time)** | **Amount of Sleep (hours)** | **Night Waking Duration (hours)** | **Child's Wake Time (analogue time)** |
|---|---|---|---|---|---|
| **High Sleep Disturbance** | 8.91 (0.97) | 8.64 (0.57) | 9.93 (1.09) | 0.07 (0.86) | 7.06 (0.46) |
| **Low Sleep Disturbance** | 8.63 (1.22) | 8.30 (0.44) | 10.45 (0.65) | 0.18 (0.00) | 6.92 (0.44) |

Table 3. Means and standard deviations of children's sleep habits in the insomnia and no insomnia groups.

| | **Age (years)** | **Child's Bedtime (analogue time)** | **Amount of Sleep (hours)** | **Night Waking Duration (hours)** | **Child's Wake Time (analogue time)** |
|---|---|---|---|---|---|
| **Insomnia** | 8.67 (0.52) | 8.54 (0.46) | 9.67 (0.68) | 0.14 (0.11) | 6.87 (0.54) |
| **No Insomnia** | 8.76 (1.18) | 8.43 (0.53) | 10.30 (0.90) | 0.03 (0.05) | 6.99 (0.44) |

The high sleep disturbance group's mean CSHQ score was 45.73 (SD = 4.39) which was significantly different from the low sleep disturbance group's mean CSHQ score of 37.83 (SD = 1.72), $t(25.78)=-8.00$, $p<.001$. The insomnia group's mean CSHQ total score was 47.83 (SD = 6.08) which was significantly different from the no insomnia group's mean CSHQ score of 40.30 (SD = 4.20), $t(50)=-3.92$, $p<.001$. The insomnia group's mean sub-scale insomnia score was 10.83 (SD = 0.98) which was also significantly different from the no insomnia group's mean sub-scale insomnia score of 6.89 (SD = 0.99), $t(50)=-9.12$, $p<.001$.

There was no significant difference between the insomnia group's CSHQ scores (M=47.83, SD= 6.08) and the high sleep disturbance group's CSHQ scores (M=44.94, SD=3.49), t(20)=-1.41, p=.17. There was a significant difference between the insomnia group's sub-scale insomnia scores (M= 10.83, SD=0.98) and the high sleep disturbance group's sub-scale insomnia scores (M=7.19, SD=1.28), $t(20)=-6.30$, $p<.001$. There was no significant difference between the insomnia group's attentional bias scores (M=86.92, SD=93.92) and the high sleep disturbance group's attentional bias scores (M=236.24, SD=256.16), $t(19.98)=2.00$, p=.06.

*Attentional bias*

A Mann-Whitney test found that the attentional bias scores for children with high sleep disturbance (Mdn=83.25, IQR=275.69) were significantly greater than for children with low sleep disturbance (Mdn=-121.88, IQR=362.81), U=46.00, z=-5.26, p<.001, r=-.73. This is indicated by the positive attentional bias score in the high sleep disturbance group that can be seen in table 4. However, it was found that the

attentional bias scores for children classified into the insomnia group (Mdn=48.75, IQR=132.50) did not differ significantly from the attentional bias scores for children classified into the no insomnia group (Mdn=8.13, IQR=315.63), U=83.00, p=.06, r=-.22.

*Pre-sleep arousal*

A dependent t-test found that children with high sleep disturbance reported cognitive arousal (M=21.41, SE=1.56) significantly more than somatic arousal (M=12.77, SE=.63), *t*(21)=-6.53, p<.001, r=1.40. It was also found that children classified into the insomnia group reported significantly greater cognitive arousal (M=21.33, SE=2.62) than somatic arousal (M=14.83, SE=1.25), *t*(5)=-3.20, p=.024, r=2.79. These differences are highlighted in tables 4 and 5.

An independent t-test found no significant difference between the cognitive arousal reported by children in the high sleep disturbance group (M=21.41, SE=7.30) and those in the low sleep disturbance group (M=18.60, SE=6.60), *t*(50)=-1.45, p=.15, r=0.11. It was also found that there was no significant difference between the cognitive arousal reported by children in the insomnia group (M= 21.33, SE=2.62) and those in the no insomnia group (19.59, SE=1.05), *t*(50)=-.57, r=0.14.

Table 4. Means and standard deviations of attentional bias, somatic arousal, and cognitive arousal scores for children in the high and low sleep disturbance groups.

| | | **Attentional Bias** | **Somatic Arousal** | **Cognitive Arousal** |
|---|---|---|---|---|
| **High Sleep Disturbance** | Mean (SD) | 195.51 (231.52) | 12.77 (2.96) | 21.41 (7.30) |
| | Median (IQR) | 83.25 (275.69) | 12.00 (5.00) | 21.00 (13.00) |
| **Low Sleep Disturbance** | Mean (SD) | -189.10 (240.41) | 12.77 (5.37) | 18.60 (6.60) |
| | Median (IQR) | -121.88 (362.81) | 11.00 (3.00) | 19.00 (11.00) |

*In addition to mean and standard deviation scores, the medians and interquartile range scores are presented for variables where non-parametric tests were used.*

Table 5. Means and standard deviations of attentional bias, somatic arousal, and cognitive arousal scores for children in the insomnia and no insomnia groups.

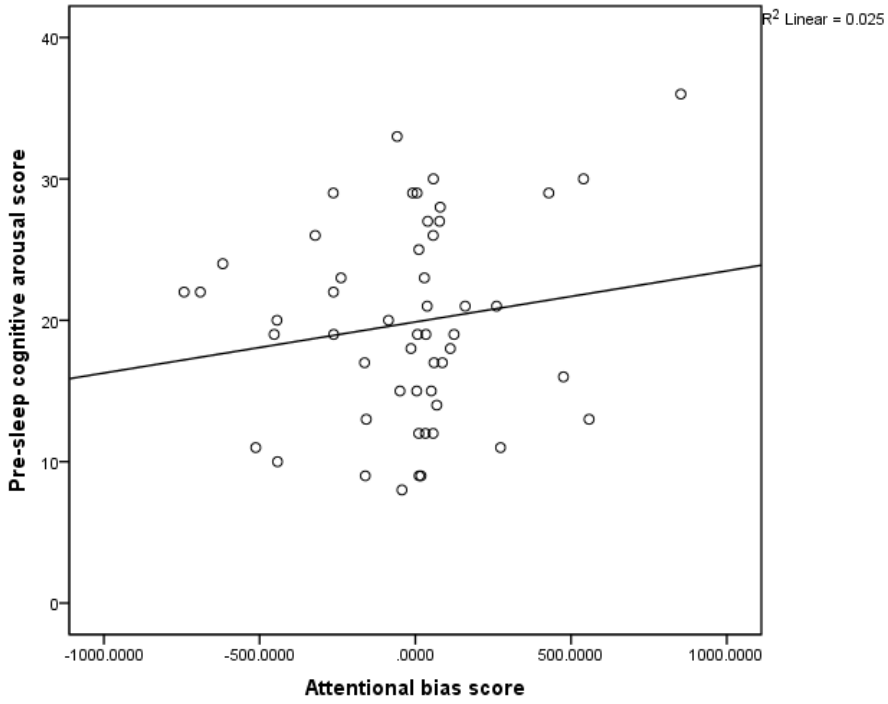
| | | **Attentional Bias** | **Somatic Arousal** | **Cognitive Arousal** |
|---|---|---|---|---|
| **Insomnia** | Mean (SD) | 86.91 (93.92) | 14.83 (3.06) | 21.33 (6.41) |
| | Median (IQR) | 48.75 (132.50) | 15.50 (5.00) | 20.00 (11.00) |
| **No Insomnia** | Mean (SD) | -41.16 (317.91) | 12.50 (4.58) | 19.59 (7.09) |
| | Median (IQR) | 8.13 (315.63) | 11.00 (3.00) | 19.00 (12.00) |

*In addition to mean and standard deviation scores, the medians and interquartile range scores are presented for variables where non-parametric tests were used.*

*Attentional bias and cognitive arousal*

A Spearman's correlation found that there was no significant correlation between the attentional bias scores and the pre-sleep cognitive arousal scores, r(50)=.07, p=.60 (see figure 1).

Figure 1. Mean attentional bias and pre-sleep cognitive arousal scores.




## Discussion

The aim of the present study was to investigate the relationships between children's sleeping habits, pre-sleep arousal and sleep-related attentional bias. Parents of children, aged 7 to 11, completed the CSHQ in order to measure and classify sleep disturbance, and specifically insomnia, in children. Children completed the PSAS to measure both pre-sleep cognitive and somatic arousal levels; as well as a visual-dot-probe task to measure sleep-related attentional bias.

The first aim of the present study was to investigate whether children reported to have insomnia demonstrate greater attentional bias than children without insomnia; it was hypothesised that children with insomnia would have a higher tendency to selectively attend to sleep-related stimuli than children without insomnia. The results show that, in general, children with high sleep disturbance demonstrated significantly greater attentional bias for sleep-related stimuli than children with low sleep disturbance, suggesting that attentional bias is one possible process associated with children's sleep disturbances and which may be involved in the development and maintenance of, children's sleep disturbances. This is consistent with previous findings (Jansson-Frojmark et al., 2012; Jones et al., 2005; MacMahon et al., 2006; Taylor et al., 2003) that have found that adults with sleep disturbance show a greater attentional bias toward sleep-related stimuli in comparison to controls. When sleep disturbance was specified to insomnia, however, there was no significant difference between the attentional bias scores of children with and without insomnia.

This is contrary to what was predicted and does not support the study by Ellis et al. (2013) who investigated insomnia in children, indirectly, and found that children of

parents with insomnia displayed greater attentional bias for sleep-related words compared to controls. However, as the children, in that study, did not have insomnia themselves, it could be that children identified as vulnerable for insomnia demonstrate greater attentional bias towards sleep-related stimuli whereas children who have developed insomnia do not. Further, longitudinal research would be needed to address this speculation. Although there were significant differences between the insomnia and no insomnia group's CSHQ and sub-scale insomnia scores, indicating that the two groups were indeed different, the way they were defined is one potential explanation as to why no significant difference was found between the insomnia and no insomnia group's attentional bias scores. Upon comparison of children in the insomnia group with children in the high sleep disturbance group, there was no significant difference between their attentional bias scores. The divide between the two groups meant that there were many children with high sleep disturbance included in the no insomnia group. This led to the inclusion of high, positive attentional bias scores in the no insomnia group, of which some were higher than the attentional bias scores of children in the insomnia group, distorting the end results. Future studies should look into another way of defining the no insomnia group; they could further divide the no insomnia group and compare the attentional bias scores of children across three separate groups. For example, Jones et al. (2005) compared sleep-related attentional bias in good, moderate, and poor adult sleepers; although a differential attentional bias between moderate and poor sleepers was not found, they did find a differential attentional bias between good and moderate sleepers. Given that the middle group would not include children with low sleep disturbance, this would provide evidence for the involvement of attentional bias along a continuum ranging from low sleep disturbance to high sleep disturbance and through to insomnia. The large range of attentional bias scores in both the insomnia and no insomnia group is one possible explanation for why no significant difference was found. A potential reason for this large range could be that some participants' attention may have been shifted towards the sleep-related pictures, demonstrating vigilance, or shifted away from the sleep-related pictures to prevent distress, demonstrating avoidance (Heim-Dreger, Kohlmann, Eschenbeck, & Burkhardt, 2006). Future studies could use an additional method of assessment whereby participants' eye movements could be tracked to monitor vigilant and avoidant processes when faced with sleep-related stimuli.

The second aim was to investigate whether children reported to have insomnia report greater cognitive than somatic arousal levels where it was hypothesised that children with insomnia would report greater cognitive than somatic arousal. It was found that children classified as having insomnia reported significantly greater cognitive than somatic arousal which is consistent with Espie's (2002) psychobiological inhibition model and Harvey's (2002) cognitive model of insomnia as they both suggest that cognitive de-arousal appear central to insomnia. However, the reporting of greater cognitive arousal levels, in the present study, cannot be specific to insomnia because it was also found that children with high sleep disturbance reported significantly greater cognitive than somatic arousal. This supports Gregory et al.'s (2008) study that found cognitive arousal to be a stronger predictor of children's sleep disturbance than somatic arousal; and with Lichstein and Rosenthal's (1980) finding that cognitive arousal was ten times more likely than somatic arousal to be reported. The fact that children with insomnia and children with high sleep disturbance both reported greater cognitive than somatic arousal

suggests that cognitive arousal levels are associated with sleep disturbances in general and cannot be specified to a particular disorder like insomnia.

The third aim was to investigate whether children with insomnia report greater cognitive arousal levels than children without insomnia. It was hypothesised that children with insomnia would report greater cognitive arousal than children without insomnia; however, contrary to prediction, it was found that children with sleep difficulties (both high sleep disturbance and insomnia) did not report significantly greater cognitive arousal than children without sleep difficulties (i.e. those with low sleep disturbance and no insomnia). One explanation for why no significant differences were found is that even normal, healthy sleepers report cognitive arousal symptoms, such as worrying, during the pre-sleep period (De Valck, Cluydts, & Pierra, 2004). Very few studies have investigated pre-sleep arousal levels in children with sleep disturbance, and specifically insomnia; those that have (Gregory et al. 2008) have examined only an association between pre-sleep arousal and sleep disturbances, thus they cannot conclude about the direction of effects; and they have not examined the differences between pre-sleep arousal in children with and without sleep disturbance. It could be that the PSAS was not a sufficient enough measure to investigate the differences between the cognitive arousal reported by children with and without sleep disturbance. This highlights the need to continue developing age-appropriate tasks and measures that can be used to assess the relationships between cognitive processes and sleep disturbance in children (Gregory et al., 2010).

The final aim of the present study was to investigate whether there is an association between attentional bias and pre-sleep cognitive arousal levels. Although there had been no previous literature that examined the association between children's attentional bias and cognitive arousal scores, it was hypothesised that there would be a positive association. The present study found no significant correlation between the attentional bias and cognitive arousal scores, stressing that these are two separate processes associated with sleep disturbance where attentional bias is a process operating throughout the day and cognitive arousal is a process operating during the pre-sleep period. The fact that no significant correlation was found could have been due to the visual-dot-probe task and/or the PSAS being not a sufficient enough measure of attentional bias and cognitive arousal levels.

The non-significant findings could have been due to the small sample size, particularly for the insomnia group. Given that the present study made use of an opportunity sample, there was no control over how many children would be classified as having high sleep disturbance or as having insomnia; thus it was difficult to have an equal number of participants in each group. Future studies should be replicated with a larger sample size and/or use more sensitive sleep-quality measures to ensure that there are a considerable number of participants classified into each condition and that they really differ. One problem with the opportunity sample, in the present study, is that the findings may not generalise to children who have been clinically diagnosed with insomnia, thus it cannot be considered to have clinical implications. Therefore, attentional bias studies should be replicated with clinical samples. Nevertheless, discovering processes along the sleep disturbance continuum may provide evidence about the mechanisms involved in the maintenance and development of sleep disturbance, and potentially insomnia, in

children (Woods, Marchetti, Biello, & Espie, 2009). Due to practical reasons, it was not possible to adjust the time and location of carrying out the experiment. Employing the visual-dot-probe task in the middle of the day, with no cost attached to poor performance may have failed to elicit the psychological stresses that are proposed to lead to selective attention (Espie, 2002; Marchetti et al., 2006). It is possible that a larger effect could have been found if the participants were tested at a time when sleep loss was a salient threat (Marchetti et al., 2006).

The present study comes both with its limitations and strengths. The visual-dot-probe task was employed because it is a more direct measure of attentional bias, compared to the Stroop task, as it reflects the scanning of the visual field (Spiegelhalder et al., 2010). However, reactions times are still only an indirect measure of attentional bias. As suggested by previous studies (MacMahon et al., 2006; Jansson-Frojmark et al., 2012), pictorial stimuli, depicting children in everyday situations, were used in the visual-dot-probe task to increase the saliency and ecological value of the stimuli. In addition the difference between sleep and neutral pictorial stimuli was small (bedrooms and bathrooms versus kitchens, living and dining rooms), increasing the findings ecological validity.

A further strength is that information about children's sleeping habits and pre-sleep arousal was obtained by both parents and children, overcoming the problem of shared method variance. However, the present study could have made use of another self-report measure where the children completed a questionnaire, such as the Sleep Self-report (SSR) (Owens, Maxim, Nobile, McGuinn, & Msall, 2000) about their sleeping habits. This could have then been compared to the results of the CSHQ, as filled out by the children's parents, to see if responses were consistent and were correlated. Gregory et al. (2008) found that there was disagreement between parents' and children's reports of sleep disturbances, highlighting that there can be potential problems if studies rely on using just one-report measure to define sleep disturbance in children. This is supported by Owens et al. (2000) who also found disagreements between parents' and children's reports of sleep disturbance and that children tended to identify more sleep problems by self-report than did their parents. The authors suggested problems with both parent- and child-report where they concluded that although children have the potential to report inaccurately on items, such as those requiring estimation of time, they may perceive some sleep habits more accurately than their parents, who may be unaware of the behaviour or not perceive it as a problem. This reinforces the need to include both parent- and self-reports when defining sleep disturbance in children.

Further limitations of the present study are that social desirability and/or performance anxiety may have occurred during the visual-dot-probe task, and when completing the PSAS, as the experimenter observed, and was present throughout, the task. This may have led to incorrect or slower responses. The results could have been distorted by response bias whereby those parents whose children have good sleep habits may have been more likely to respond. The time frame of the CSHQ should be considered; parents were asked to describe their children's sleep habits over a typical week and although this time frame is believed to address variations in sleep patterns (Owens et al. 2000), it may have been insufficient to identify some sleep disturbances. The time frame may have also led to an over- or underestimation of children's sleep habits.

Although the present study's findings provide support for the notion that attentional bias is one process associated with children's sleep disturbance, it cannot be concluded that attentional bias is a process associated with childhood insomnia specifically. It also cannot be concluded that attentional bias is a primary process involved in the etiology of children's sleep disturbances; it is possible that this kind of information processing bias arises simply because sleep is continually disturbed, thus sleep-related attentional bias may be a secondary characteristic of children's sleep disturbances (Marchetti et al., 2006). The underlying causes for sleep-related attentional bias are also not known; therefore, future studies should try to address this. Future studies should also aim to investigate whether successful therapy reduces attentional bias scores in children with high sleep disturbance. In addition, as participants' individual ages were recorded, age-related changes in attentional bias could have also been investigated. However, this was not possible in the present study due to the small sample size. Given that there are normal developmental patterns of attention (Morren, Kindt, van den Hout, & van Kasteren, 2003), whereby children's ability to inhibit the processing of threat increases with age, future studies could aim to investigate age-related changes in sleep-related attentional bias.

In conclusion, the present study has provided evidence showing that children, aged 7 to 11, with high sleep disturbance demonstrate greater attentional bias towards sleep-related stimuli than children with low sleep disturbance; this is parallel to what has been found in the adult literature. However, this was not specific to children reported to have insomnia. Additionally, it has provided evidence that cognitive arousal is associated with children's sleep disturbance as children with both high sleep disturbance and insomnia reported greater cognitive than somatic arousal levels; however cognitive arousal levels cannot be specified to childhood insomnia. This evidence about the potential processes associated with children's sleep disturbances is essential for the development of effective interventions and treatments. Further research is needed to understand the underlying causes for sleep-related attentional bias, and to confirm whether it is a primary characteristic of children's sleep disturbances.

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