# The role of sleep problems and sleepiness in cognitive and behavioural processes of childhood anxiety

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## Declaration

The thesis conforms to an 'article format' in which the middle chapters consist of discrete articles written in a style that is appropriate for publication in peer-reviewed journals in the field. The first and final chapters present synthetic overviews and discussions of the field and the research undertaken.

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Paper 1 is published in Behavioural and Cognitive Psychotherapy as:

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The author contributions are as follows: Donna Ewing was responsible for all aspects of data collection and writing of the manuscript, and most aspects of data analysis; Andy Field was responsible for guidance in the data analysis; Ellen Thompson assisted with second-coder ratings within this manuscript; Sam Cartwright-Hatton and Jeremy Monsen were responsible for providing feedback on study design and corrections to the manuscript. Donna Ewing and Jeremy Monsen were collectively responsible for the initial conception of the research, and Donna Ewing and Sam Cartwright-Hatton were collectively responsible for the development of the research.

Paper 2 is written in the style of an article appropriate for publication.

The author contributions are as follows: Donna Ewing, Suzanne Dash, Cassie Hazell, and Ellen Thompson were collectively responsible for data collection, with Donna Ewing taking the primary role; Donna Ewing was responsible for all aspects of data analysis and writing of the manuscript; Rod Bond provided some guidance for data analysis; Sam Cartwright-Hatton was responsible for providing feedback on study design and corrections to the manuscript. Donna Ewing and Sam Cartwright-Hatton were collectively responsible for the initial conception of the research.

Paper 3 is written in the style of an article appropriate for publication.

The author contributions are as follows: Donna Ewing, Suzanne Dash, Cassie Hazell, and Ellen Thompson were collectively responsible for data collection, with Donna Ewing taking the primary role; Donna Ewing was responsible for all aspects of data analysis and writing of the manuscript; Zoe Hughes assisted with second-coder ratings within this manuscript; Sam Cartwright-Hatton was responsible for providing feedback on study design and corrections to the manuscript. Donna Ewing and Sam Cartwright-Hatton were collectively responsible for the initial conception of the research.

Paper 4 is written in the style of an article appropriate for publication.

The author contributions are as follows: Donna Ewing, Suzanne Dash, Cassie Hazell and Ellen Thompson were collectively responsible for data collection, with Donna Ewing taking the primary role; Donna Ewing was responsible for all aspects of data analysis and writing of the manuscript; Sam Cartwright-Hatton was responsible for providing feedback on study design and corrections to the manuscript. Donna Ewing and Sam Cartwright-Hatton were collectively responsible for the initial conception of the research.

Paper 5 is written in the style of an article appropriate for publication.

The author contributions are as follows: Donna Ewing was responsible for all aspects of data collection, data analysis, and writing of the manuscript; Sam Cartwright-Hatton was responsible for providing feedback on study design and corrections to the manuscript. Donna Ewing and Sam Cartwright-Hatton were collectively responsible for the initial conception of the research.

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The author contributions are as follows: Donna Ewing was responsible for all aspects of data analysis, and writing of the manuscript; data for this study was collected as part of a previously published study (Cartwright-Hatton et al., 2011); Sam Cartwright-Hatton was responsible for providing feedback on study design and corrections to the manuscript. Donna Ewing and Sam Cartwright-Hatton were collectively responsible for the initial conception of the research.

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I hereby declare that this thesis has not been, and will not be, submitted in whole or in part to another University for the award of any other degree.

Signature:……

Donna Ewing

19th September 2014

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UNIVERSITY OF SUSSEX

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# The role of sleep problems and sleepiness in cognitive and behavioural processes of childhood anxiety

## Summary

Sleep in children is important for the functioning of a range of cognitive processes, including memory, attention, arousal, executive functioning, and the processing of emotional experiences. This, in addition to the high comorbidity between sleep problems and anxiety, may suggest that sleep plays a role in the cognitive and behavioural processes associated with childhood anxiety. Although a body of research exists which considers the associations between sleep problems and anxiety, there is currently little research evidence available for the effect of children's *sleepiness* on anxiety, or for the effect of childhood sleep problems or sleepiness on anxiety-related processes. To address this, this thesis begins with a meta-analysis exploring the efficacy of transdiagnostic cognitive-behavioural therapy (CBT) for the treatment of childhood anxiety (Paper 1). CBT is generally the treatment of choice for childhood anxiety, and targets the processes that the subsequent papers in this thesis consider in relation to children's sleepiness and sleep problems. Papers two to five consider the effect of sleepiness on a range of anxiety-related cognitive and behavioural processes, including vicariously learning and unlearning fear

(Paper 2), ambiguity resolution (Paper 3), emotion recognition (Paper 4), and habituation and avoidance (Paper 5). The final paper considers sleep problems in relation to a CBT intervention for childhood anxiety (Paper 6). Overall, while sleep problems and usual sleepiness were found to be associated with childhood anxiety, *current sleepiness* was not. On the other hand, sleepiness (usual and current), and reduced sleep, affected children's behavioural processes when exposed to anxiety provoking stimuli, but were not found to affect children's anxiety-related cognitive processes. Sleep problems interacted with vicarious learning processes, but not with ambiguity resolution or emotion recognition processes, or with change in anxiety symptoms following a CBT intervention for childhood anxiety. Implications for treatment and future research directions are discussed.

## Abbreviations

ADHD – Attention Deficit Hyperactivity Disorder

ADIS – Anxiety Disorder Interview Schedule

ANOVA – Analysis of Variance

AP - Agoraphobia

ASQ – Ambiguous Situations Questionnaire

CBCL – Child Behaviour Checklist

CBT – Cognitive Behavioural Therapy

CSHQ – Children's Sleep Habits Questionnaire

EMDR – Eye Movement Desensitisation and Reprocessing

ERP – Exposure and Response Prevention

GAD – Generalised Anxiety Disorder

LOR – Log Odds Ratio

MASC – Multidimensional Anxiety Scale for Children

NHS – National Health Service

OAD – Over-Anxious Disorder

OCD – Obsessive Compulsive Disorder

OR – Odds Ratio

PD – Panic Disorder

PDSS – Pediatric Daytime Sleepiness Scale

PTSD – Post-Traumatic Stress Disorder

RCADS – Revised Children's Anxiety and Depression Scale

RCT – Randomised Controlled Trial

SAD – Separation Anxiety Disorder

SCARED – Screen for Child Anxiety Related Disorders

SCAS – Spence Child Anxiety Scale

SD – Standard Deviation

SoP – Social Phobia

SP – Specific Phobia

# Chapter 1: Overview

## 1.1 Introduction

It is widely accepted that children can experience a range of anxiety disorders, including generalised anxiety disorder, social phobia, agoraphobia, separation anxiety disorder, specific phobia and panic disorder, although panic disorder tends to only emerge in adolescence (R. Klein, 2009). Childhood anxiety disorders are highly prevalent, and, arguably, one of the most common childhood psychological disorders, with prevalence rates found to fall within the range of 3% to 24% (Cartwright-Hatton, McNicol, & Doubleday, 2006). Furthermore, childhood anxiety disorders have long-term implications for individuals, with the odds of having an anxiety disorder diagnosis in adulthood being three times higher for those who were diagnosed during childhood or adolescence (Copeland et al., 2013).

### 1.1.1 Acquisition of childhood anxiety

Anxiety runs in families, and there is substantial evidence to suggest that both genetic and environmental factors are involved in the acquisition of childhood anxiety disorders (for example, Gregory & Eley, 2007; Turner, Beidel, & Costello, 1987), with influences from both of these considered central to the development of anxiety (Eley, 2007). For instance, in one study, children of anxiety disordered parents were seven times more likely to have an anxiety disorder themselves compared to children of healthy parents, and showed more symptoms of anxiety, fearfulness, worry, and negative mood states (Turner et al., 1987), although this study was unable to draw inferences as to the role of environmental or genetic factors. Studies considering genetic influences on childhood anxiety make use of family studies, including twin and adoption studies, to explore the heritability of anxiety. These offer support for genetic influences on a range of personality traits associated with childhood anxiety, including behavioural inhibition, anxiety sensitivity, fearfulness, shyness and emotionality (Eley, 2007; Gregory & Eley, 2007; Stein, Jang, & Livesley, 1999). In particular, generalised anxiety disorder, panic disorder, social phobia, specific phobia and post-traumatic stress disorder, are substantially influenced by genetic factors, with heritability estimates ranging between 30-40% for these disorders (Eley, 2007). Other research suggests that the weight of the influence of

genetic and environmental factors changes according to the age of the child, with genetic and shared environmental factors found to explain most phenotypic variance between monozygotic and dizygotic twins in anxiety symptoms at age 12, but with only genetic factors found to explain this variance at ages 14 and 16 (Lamb et al., 2010). However, this finding was based on children's self-reports of their anxiety symptoms, and is, therefore, not reflective of children's anxiety *disorder* diagnoses. In addition, the study did not use a longitudinal design to consider the change in influence of genetic and environmental factors over time, but instead used separate cohorts of children for the different age groups tested. However, results from a longitudinal twin study similarly suggest that genetic factors, rather than shared- or non-shared environmental factors, were most influential in the continuation of children's anxiety symptoms from 7 years of age to 9 years of age (Trzaskowski, Zavos, Haworth, Plomin, & Eley, 2012). However, environmental factors were also found to influence children's anxiety across these ages, and in particular, to influence changes in anxious-related behaviours (Trzaskowski et al., 2012). Indeed, Gregory and Eley (2007) stress that it is the additive influence of genetics and shared- and non-shared environments that are important, rather than the influence of one over the other.

In considering environmental influences, Rachman (1977) proposed three pathways through which individuals develop fears and anxiety: conditioning, vicarious exposures, and the transmission of verbal information. While the conditioning pathway is a direct pathway to fear acquisition, with children having direct experiences of the feared stimuli, the vicarious learning and transmission of information pathways are indirect pathways where fear is learnt through other people.

#### *1.1.1.2 Conditioning*

The conditioning pathway is used to explain the development of fears and anxieties in response to direct negative experiences with the feared stimulus, such as fear associated with negative experiences with animals or fear associated with traumatic experiences (Rachman, 1977).

During conditioning, the individual has a direct experience of an aversive stimulus that produces an unconditioned fear response. This aversive stimulus may then become associated with a neutral stimulus, which leads to the individual learning to respond fearfully towards that neutral stimulus, even when it is presented separately from the aversive stimulus. A classic example of fear conditioning can be drawn from the study of Little Albert (Watson & Rayner, 1920). In this study, an infant was conditioned to fear a white rat through multiple presentations of the rat while a steel bar was simultaneously struck, creating a loud and uncomfortable sound. Later presentations of the rat (without the striking of the steel bar) produced an unconditioned fear response of crying in the infant (Watson & Rayner, 1920). However, this study was based on only one child, and did not use any objective measures of the child's responses to the stimuli, relying instead on the subjective ratings of the researchers. In addition, multiple pairings of the unconditioned stimulus were required before fear of the neutral stimulus was developed, with the fear reaction arguably less intense when tested again a month later (Harris & Coll, 1979), which suggests that this example may not be representative of the experiences of individuals who develop intense and long-lasting phobias after one pairing. For instance, anxiety has often been found to follow one-off traumatic events, such as natural disasters, with one study finding that 46% of children affected by a major hurricane reported moderate to severe post-traumatic stress disorder symptoms (Moore & Varela, 2010). However, it is worthy of note that not all children affected by the event in this study went on to develop anxiety, which suggests that while direct negative experiences can lead to the conditioning of fears, this is not always the case.

Conditioning cannot, therefore, be the only pathway to developing fear. Indeed, Rachman (1977) proposed that the indirect pathways of vicarious learning and transmission of information also play a key role in the acquisition of anxiety. A number of studies have provided evidence in support of these indirect pathways. For example, in a survey, most children reported acquiring their fears through vicarious learning or the transmission of

information pathways, although this was often in combination with direct conditioning (Ollendick & King, 1991).

#### *1.1.1.3 Vicarious Learning*

Vicarious learning of fears involves observation and modelling of the feared behaviours of others towards a stimulus. Learning through observing the behaviours of others, including emotional responses towards stimuli and situations, allows individuals to build large repertoires of behaviours quickly and efficiently, without the need for direct experiences of each situation (Bandura, 1971).

Some evidence for the vicarious learning pathway of fear acquisition comes from studies using peer modelling, with children's fear beliefs increasing for stimuli with which they have watched other children negatively interact, and decreasing following a positive interaction (Broeren, Lester, Muris, & Field, 2011). The vicarious learning pathway has also been assessed through the pairing of pictures of both "fear-relevant" and "fear-irrelevant" stimuli with photographs of faces (Askew, Dunne, Özdil, Reynolds, & Field, 2013). "Fear-relevant" stimuli included stimuli that threatened the survival of our ancestors (such as snakes), whereas "fear-irrelevant" stimuli included non-threatening stimuli, such as flowers (Askew et al., 2013). Children's fear beliefs and avoidance of the stimuli were found to increase following a pairing with a scared face and to decrease following a pairing with a happy face regardless of whether the presented stimulus was "fear-relevant" or "fear-irrelevant"(Askew et al., 2013; Askew & Field, 2007).

However, these studies have not used designs in which children directly observe another individual interacting with stimuli, but rather used pairings of facial stimuli with the fear-relevant or irrelevant stimuli. Therefore, it is difficult to determine the factors that are influential in children's vicarious learning of fear in real-life situations. For instance, models may provide a number of fear cues (for example, through body language), rather than simply through the display of facial emotion. Other studies have, however, considered children's

vicarious learning of fear using human models rather than pictures of emotional expressions paired with the stimuli. Findings from these studies suggest that fear beliefs and avoidance of stimuli can be vicariously learnt and unlearnt from both mothers and strangers (Dunne & Askew, 2013).

Parents, in particular, may play an influential role in children's acquisition of fears and anxieties. For example, when parents responded fearfully in an interaction with a stranger, infants were later found to be more fearful and avoidant of that stranger compared to when parents responded in a neutral (non-anxious) manner (de Rosnay, Cooper, Tsigaras, & Murray, 2006). However, these findings were based on a very small sample size. In similar studies, when mothers responded with negative facial expressions towards fear-relevant stimuli (such as rubber snakes or spiders), children showed greater fear and avoidance of the stimuli compared to when mothers responded with positive facial expressions (Gerull & Rapee, 2002), with similar findings found for fear-irrelevant stimuli such as rubber flowers or mushrooms (Dubi, Rapee, Emerton, & Schniering, 2008). However, the effects of vicarious learning did not persist when tested again ten minutes later for the latter study (Dubi et al., 2008). On the other hand, positive vicarious experiences from mothers may be protective for children when later provided with a negative vicarious experience. For instance, children who observed their mothers' positive interactions with a fear-relevant stimulus were more willing to approach the stimulus than children who did not have the positive vicarious experience, even after all the children in the sample subsequently saw a stranger react fearfully to the same stimulus (Egliston & Rapee, 2007). However, these results need to be interpreted with caution, as the order of the mother and stranger observations was not counterbalanced, with all mother observations occurring first. It is, therefore, not possible to determine from this study whether mothers' behaviour towards stimuli was more influential for the child than that of a stranger's behaviour towards the same stimuli, or whether it was simply the initial vicarious experience that was more influential.

#### *1.1.1.4 Transmission of Information*

The acquisition of fears through the transmission of information involves the individual receiving negative information about the stimulus, which leads to the development of fear towards that stimulus (Rachman, 1977). To assess the information pathway to fear acquisition, children have been given positive, negative and neutral information about novel stimuli, and the effects of information type has been examined in relation to children's fear responses to the stimuli (Field, Argyris, & Knowles, 2001; Field & Schorah, 2007; Muris, Bodden, Merckelbach, Ollendick, & King, 2003; Muris, Rassin, et al., 2009). Findings from these studies suggest that children had lower fear towards the stimuli associated with positive information, and higher fear towards the stimuli associated with negative information (Field et al., 2001; Muris et al., 2003; Muris, Rassin, et al., 2009), which was maintained at one-week (Muris et al., 2003) and at 6 months follow-up (Field, Lawson, & Banerjee, 2008). Furthermore, transmission of information affected children's physiological responses towards the stimuli, with children showing heightened heart rates when approaching stimuli associated with negative information compared to stimuli not associated with any information (Field & Schorah, 2007).

In addition, and as for the vicarious learning pathway, parents have been found to be influential in the acquisition of children's fears through the transmission of information pathway. For instance, parents who were given negative information about a stimulus (as opposed to parents given positive information about it) were more likely to inform their children of threatening information about the stimulus, resulting in greater fear in the children (Muris, van Zwol, Huijding, & Mayer, 2010). However, this study relied only on self-reports of children's fear of the stimulus, and so it is not possible to conclude how information provided by parents affected children's anxious behaviours towards the stimulus, nor did it consider whether there was a lasting effect on children's fear.

Just as fears can be learned through these indirect pathways, there is a growing body of counterconditioning research to suggest that children can unlearn fears using the same pathways (Kelly, Barker, Field, Wilson, & Reynolds, 2010). For instance, in a sample of children with

raised fear beliefs towards a novel stimulus (following negative information about the stimulus), counterconditioning using positive information and vicarious learning experiences were found to be effective in reducing fear beliefs and avoidance compared to those in a control group who did not receive counterconditioning (Kelly et al., 2010). Similarly, counterconditioning was effective in reducing fear beliefs for children given positive information or who engaged in positive imagery compared to those in a control group, with the largest reduction in fear seen for children given positive information (Muris, Huijding, Mayer, van As, & van Alem, 2011). Both of these studies used non-clinically anxious children, however, and so it is unknown from these findings whether positive verbal information and/or vicarious experiences are similarly beneficial for children with clinical levels of anxiety.

### 1.1.2 Psychological processes associated with childhood anxiety

#### *1.1.2.1 Behavioural processes*

Childhood anxiety disorders are characterised by a number of behavioural, cognitive and interpersonal processes, which are often addressed during treatment. For instance, avoidance and safety behaviours (actions carried out to prevent or avoid feared outcomes, such as speaking quickly, rehearsing sentences, avoiding eye contact, holding onto things, and/or looking for an exit) are often characteristic of, and maintaining factors for, anxiety disorders, since they prevent the individual from gathering new information to challenge and falsify fear beliefs (Deacon & Maack, 2008; Hofmann, 2007; Ollendick et al., 2009; Öst, Svensson, Hellström, & Lindwall, 2001). Avoidance, but not safety behaviours, is addressed in this thesis.

##### 1.1.2.1.1 Avoidance

During a visual probe task, children with social anxiety symptoms were found to avoid looking at images of angry and fearful facial expressions (Stirling, Eley, & Clark, 2006). Similarly, children with spider phobias showed an automatic avoidance tendency for pictures of spiders (but not for butterflies) in approach-avoidance tasks in which children pull or push a joystick to enlarge or reduce the size of the image (A. Klein, Becker, & Rinck, 2011). In this study,

children were instructed to pull the joystick when the images were displayed in one shape (e.g. a square), and to push the joystick when displayed in another shape (e.g. a circle). Children with spider phobias were significantly faster at pushing the joystick to reduce the size of the spider image than they were for the neutral image of a butterfly (A. Klein et al., 2011). However, this effect was only found for the first block of testing (out of six), which A. Klein et al. (2011) suggest may be due to the children's habituation towards the task. Therefore, this study may suffer from methodological limitations, since the avoidance-approach task may not have been suitable for repeated testing. Despite these limitations, however, the results do show a trend for fearful children showing more avoidance of the feared stimuli.

Providing children with threat-related information about novel stimuli has also been shown to lead to increased avoidance of those stimuli (Field et al., 2008; Muris, Huijding, Mayer, Leemreis, et al., 2009), with greater avoidance found when verbal threat information was followed by a direct negative experience of that stimulus (Field & Storksen-Coulson, 2007). Similarly, when children were trained to negatively interpret (in comparison to children trained to positively interpret) an ambiguous and fictional planet scenario, they showed more avoidance tendencies in terms of where they would land their spacecraft and choose to settle (that is, on the planet or somewhere alternative), with children in the negative-training condition tending to opt not to land on the planet (Muris, Huijding, Mayer, Remmerswaal, & Vreden, 2009). However, due to the unrealistic nature of this space paradigm, it is difficult to determine the generalisability of the findings in this study. On the other hand, a similar study that used negative interpretation training towards more ecologically valid scenarios of novel animals, was also found to lead to increased avoidance in an approach task, compared to children who were trained to give positive interpretations of the scenarios (Lester, Field, & Muris, 2011a).

#### 1.1.2.1.2 Safety Behaviours

Treatment often requires that clients reduce avoidance and safety behaviours. So, for instance, when a sample of adults with social anxiety disorder were instructed not to engage in safety

behaviours while exposed to an anxiety-provoking situation, participants were found to be less negative and more accurate when reviewing their performance, compared to those not given the same instructions (C. Taylor & Alden, 2010). However, it should be noted that no baseline observations of participants' safety behaviours were adopted in this study, and instead, participants gave self-reports of their safety behaviours. Therefore, it is not possible to determine whether the participants in the safety behaviour reduction group actually reduced their safety behaviours for the task. On the other hand, when the opposite approach was taken, and adult participants with health anxiety were encouraged to engage in safety behaviours, findings suggested that fear-relevant beliefs and avoidance behaviour increased in comparison to participants in a control group who did not change their level of engagement in safety behaviours (Olatunji, Wolitzky-Taylor, Willems, Lohr, & Armstrong, 2009). Similarly, increased use of safety behaviours increased fear beliefs and avoidance behaviours in participants with contamination fears, while these fears decreased when the frequency of safety behaviours returned to baseline levels (Deacon & Maack, 2008).

Although less research evidence is available considering the use of safety behaviours in child and youth samples, there is some evidence to suggest that greater use of safety behaviours during exposure tasks was associated with poorer outcomes in terms of change in anxiety symptoms from pre- to post-treatment (Hedtke, Kendall, & Tiwari, 2009). However, there does not appear to be any research considering how an increase or a reduction in children's use of safety behaviours affects children's anxious behaviours or fear beliefs.

#### *1.1.2.2. Cognitive Processes*

According to Kendall's (1985) cognitive theory of childhood anxiety, distortions and deficiencies in cognitive structures (such as beliefs, schemas, and attributions), affect how children behave in future situations. A number of cognitive processes are associated with childhood anxiety, including information processing biases such as attentional and interpretational biases, both of which will be addressed within this thesis. Attentional and

interpretational biases can lead to heightened feelings of anxiety and avoidance behaviour, thus reinforcing children's anxious cognitions, and maintaining their symptoms of anxiety (Creswell, Schniering, & Rapee, 2005).

#### 1.1.2.2.1. Attentional biases

Visual (or dot) probe tasks are often used to assess children's attentional biases. These typically involve displaying paired images of neutral and threat stimuli, which are then replaced by a dot at the centre of where one of the images had been presented. The reaction times of children to detect and respond to the dot are indicative of where the child's attention had been focused (that is, towards the threat or neutral stimuli). Anxious children have been found to show attentional biases towards threat stimuli on visual probe tasks such as these (Dalgleish et al., 2003; Waters, Wharton, Zimmer-Gembeck, & Craske, 2008). For example, when presented with threat and neutral word pairs, and depression-related and neutral word pairs, during a visual probe task, clinically anxious children showed a significantly greater bias towards the threat words compared to depression-related words (Dalgleish et al., 2003). When using threat images (such as vicious dogs, aimed guns, and injections), pleasant images (such as puppies, ice-cream, and smiling faces) or neutral images (such as household items), anxious children were similarly found to show a greater attentional bias towards threat images compared with pleasant images, with this threat attentional bias being significantly greater for the anxious children compared to the non-anxious children (Waters, Wharton, et al., 2008). However, both of these studies were underpowered and only show statistical trends for anxious children to have attentional biases towards threat.

Emotion recognition research has consistently shown that anxious children have greater attentional biases towards threatening facial expressions (such as angry expressions) when compared with non-anxious children, suggesting that anxious children have threat attentional biases (Krain Roy et al., 2008; Shechner et al., 2013; Waters, Henry, Mogg, Bradley, & Pine, 2010; Waters, Mogg, Bradley, & Pine, 2008). For instance, anxious children showed

significantly greater threat bias scores, compared to non-anxious children, when presented with a visual probe task using neutral and angry (threat) faces, with no differences in threat attentional bias found across different types of anxiety disorders (Krain Roy et al., 2008), suggesting that this bias is present across the range of anxiety disorders. However, greater attentional biases towards threat have been found for children with increased anxiety severity compared to children with lower anxiety severity and children with no anxiety diagnoses (Waters et al., 2010; Waters, Mogg, et al., 2008). In addition, findings from an eye-tracking study suggest that anxious children were more likely to initially attend to the angry faces rather than the neutral faces (Shechner et al., 2013). However, it is not clear from these studies whether children's cognitive bias is a causal factor in the acquisition of childhood anxiety, or whether it develops as a result of the children suffering from anxiety. Muris, Luermans, Merckelbach, and Mayer (2000) suggest that cognitive biases do not cause children's anxiety, but that high anxiety levels in children lead to greater vigilance in detecting threat.

Findings from the adult literature suggest that adults with anxiety disorders are hypervigilant to anxiety-relevant facial expressions, such as anger or fear (Heuer, Lange, Isaac, Rinck, & Becker, 2010; Mohlman, Carmin, & Price, 2007; Surcinelli, Codispoti, Montebarocci, Rossi, & Baldaro, 2006), and that adults with anxiety disorders were more likely to misclassify neutral faces as threatening compared with adults in a control group (Bell et al., 2011; Mohlman et al., 2007). However, findings from the child literature are not so consistent. For instance, anxiety has been found to predict increased accuracy (Ale, Chorney, Brice, & Morris, 2010; Guyer et al., 2007) but also increased errors (Jarros et al., 2012; Simonian, Beidel, Turner, Berkes, & Long, 2001) in emotion recognition. On the one hand, Guyer et al. (2007) found greater emotion recognition accuracy for happy, sad, fearful and angry facial expressions in children with anxiety disorders compared to children with bipolar and severe mood disorder, and control children. However, Jarros et al. (2012) found that adolescents with anxiety disorders made more mistakes in labelling angry facial expressions as 'angry' compared to those without anxiety disorders, and Simonian et al. (2001) found greater errors in the recognition of happy,

sad, and disgust emotions in a sample of socially anxious children compared to non-anxious children. Other research from the child literature suggests that accuracy on emotion recognition tasks appears to improve with age (Broeren, Muris, Bouwmeester, Field, & Voerman, 2011; Ellis et al., 1997; Guyer et al., 2007), although this does not resolve the described discrepancy in findings across the child and adolescent studies.

#### 1.1.2.2.2. Interpretational Biases

Ambiguous scenarios and situations are used to assess anxious children's interpretational biases. During these tasks, children are often asked to provide free verbal responses of how they would interpret the situation, which is subsequently coded as a threat or non-threat interpretation by the researcher. In addition, children participating in these tasks tend to be presented with two or more possible interpretations to choose between, including both threat- and non-threat interpretations. For example, a question from the Ambiguous Situations Questionnaire (Barrett, Rapee, Dadds, & Ryan, 1996) includes "You see a big dog coming towards you. What do you think is most likely to happen?" to which children provide a free verbal response before they are given some options to choose between. The options to this question may include, "The dog has come to have a pat" (non-threat interpretation), or "The dog is going to bite you" (threat interpretation).

Using ambiguous situations such as these, clinically anxious children have been found to show a threat interpretation bias towards ambiguous situations, with anxious children more likely to report a threatening interpretation of the situation compared to non-anxious children (Creswell et al., 2005). However, Creswell et al.'s (2005) study only considered children's forced choice responses, and not children's free verbal responses to the situations. These responses could be subject to response biases in which children select the response they think is the 'correct' response, or the response they think the researcher is looking for, rather than what they would think in that situation. On the other hand, similar results were found in a sample of non-clinically anxious children who responded freely to stories of ambiguous and non-

threatening social situations, with higher levels of anxiety associated with greater threat interpretational biases for stories of ambiguous social situations, and interestingly, also for non-threatening situations (although to a lesser extent), compared with children with lower anxiety levels (Muris, Luermans, et al., 2000).

Other findings suggest that anxious children judge ambiguous situations as more dangerous and consider themselves less influential in terms of knowing what to do to about the situation compared with non-anxious children (Bögels & Zigterman, 2000; Waters, Craske, Bergman, & Treanor, 2008), although it is worthy of note that the increased perception of danger was only the case according to children's forced choice responses and not according to children's free verbal responses to the situations (Bögels & Zigterman, 2000), which, again, may be the result of a response bias. Children's threat interpretation biases are also associated with, and appear to be predicted by, their parents' threat interpretations towards the ambiguous situations (Creswell et al., 2005; Creswell, Shildrick, & Field, 2011).

#### *1.1.2.3. Interpersonal processes*

Although not explored in this thesis, interpersonal processes also play a role in childhood anxiety, with evidence to suggest that attachment types and social skills in peer relationships are associated with childhood anxiety. As these are not explored in this thesis, they will be described briefly.

##### 1.1.2.3.1 Parent-Child Attachment

Insecure attachment styles are moderately related to child anxiety, with the strongest associations found between ambivalent attachment types and child anxiety (Colonnesi et al., 2011). Similarly, children with insecure (avoidant or ambivalent) attachment classifications were found to show more anxiety symptoms, compared to children with secure attachment classifications (Dallaire & Weinraub, 2007; Muris, Meesters, van Melick, & Zwambag, 2001). Different attachment styles may be associated with different types of anxiety symptoms (Brumariu & Kerns, 2010). For example ambivalent attachment styles were strongly associated

with separation anxiety symptoms (particularly for boys), and disorganised attachment types were associated with social phobia and school phobia symptoms (Brumariu & Kerns, 2010). Although these studies show a relationship between attachment types and anxiety in children, the lack of longitudinal studies in this area means that it is not clear whether the insecure attachment type preceded children's anxiety symptoms, or whether children's anxiety symptoms preceded the development of insecure attachments.

However, data from a longitudinal study suggests that higher rates of early childhood anxiety and withdrawal symptoms were associated with an increased risk of later anxiety and depression symptoms, but that a positive attachment between parents and children in adolescence was associated with a reduced risk of later developing these disorders (Jakobsen, Horwood, & Fergusson, 2011). This may suggest that secure attachments are protective in terms of the development of anxiety in children. Similarly, secure mother-infant attachments at 15 months old protected children (who experienced many negative life events) from the development of anxiety at age 4.5 years, whereas insure attachments at 15 months were associated with increased anxiety in children who experienced many negative life events (Dallaire & Weinraub, 2007).

#### 1.1.2.3.2. Peer Relationships

The relationship between attachment style and child anxiety appears to be mediated by the child's competence in their interactions with their peers, and by the child's ability to manage their emotions (Brumariu & Kerns, 2013). Other research considering interpersonal relations suggests that children suffering from social anxiety have difficulties with peer relations, including decreased peer acceptance and increased negative peer interactions, including peer victimisation (Erath, Flanagan, & Bierman, 2007; Ginsburg, La Greca, & Silverman, 1998). This relationship between social anxiety and difficulties in peer relationships was found to be mediated by the socially anxious child's negative expectations about their own social performance and their withdrawal and disengagement from social situations (Erath et al., 2007).

However, due to the nature of social anxiety disorders, it is unsurprising that social anxiety disorder is associated with peer difficulties, and so research into the relationship between peer relationships and other childhood anxiety disorders is necessary. In one study, no relationship between generalised anxiety and peer relations was found, with peer relations for children with generalised anxiety not significantly different from peer relations of non-anxious children (Scharfstein, Alfano, Beidel, & Wong, 2011). On the other hand, this study showed support for the relationship between social anxiety disorders in children and greater interpersonal difficulties with their peers (Scharfstein et al., 2011). Thus, research does not currently offer much support for the relationship between anxiety disorders and peer relationships, except for in the social anxiety literature.

### 1.1.3 Treatment of childhood anxiety

In a review of randomised-controlled trials using psychotherapy for the treatment of anxiety disorders in children and young people, the majority of the studies were found to use cognitive-behavioural therapy (CBT) (Reynolds, Wilson, Austin, & Hooper, 2012). Other treatment methods included eye-movement desensitisation and reprocessing (EMDR) or exposure and response prevention (ERP) treatments (Reynolds et al., 2012), although these tended to be for the treatment of particular types of anxiety disorder, such as post-traumatic stress disorder. Overall, the evidence-base is strongest for the efficacy of CBT for the treatment of childhood anxiety disorders (Manassis, 2013), and children who engaged in CBT interventions had higher rates of recovery compared with children in wait-list control groups (Cartwright-Hatton, Roberts, Chitsabesan, Fothergill, & Harrington, 2004).

Given the evidence that anxiety runs in families, many CBT treatments for children include elements of family and parental involvement. These typically help parents to support their children to generalise techniques learnt in the clinic to real-life settings (Manassis, 2013). In addition, parent-delivered CBT (where the child is not directly involved in the intervention)

has been found to be successful both in significantly reducing symptoms of child anxiety and in freeing children of their anxiety diagnoses (Cartwright-Hatton et al., 2011).

### 1.1.4 Sleep

Anxiety disorders in childhood are highly comorbid with sleep problems, with findings to suggest that about 90% of children with anxiety disorders additionally experienced at least one sleep problem, with over 80% experiencing two sleep problems, and over half experiencing three or more sleep problems (Alfano, Ginsburg, & Newman Kingery, 2007; Chase & Pincus, 2011). Children with generalised anxiety disorder, in particular, were found to have more sleep complaints in comparison to children with other anxiety disorders (Alfano, Beidel, Turner, & Lewin, 2006; Alfano, Pina, Zerr, & Villalta, 2010), although the comorbidity of sleep problems with separation anxiety disorder, social anxiety disorder (Alfano et al., 2007; Chase & Pincus, 2011), and obsessive-compulsive disorder was also very high (Chase & Pincus, 2011).

According to the two-process model of sleep regulation (Borbély, 1982), sleep problems and sleepiness arise from a disturbance of the interaction between two processes: Process C (a sleep-independent circadian process, which regulates the time of day that we become sleepy, irrespective of previous sleep or wakefulness); and Process S (a sleep-dependent homeostatic process which is dependent on the duration of previous wakefulness). Sleep is then classified into a number of different stages: wakefulness (Stage W), Movement Time (when the record of sleep is obscured by the individual's movements), four non-rapid eye movement (NREM) stages, and rapid eye movement (REM) sleep (Rechtschaffen & Kales, 1968). NREM Stage 1 occurs in the transition from wakefulness to the sleep stages, and tends to be relatively short in duration. NREM Stage 2 is characterised by the presence of sleep spindles and/or K complexes within electroencephalography (EEG) patterns, while NREM Stage 3 is characterised by the introduction of slow wave sleep, and NREM Stage 4 by the dominance of slow wave activity. REM sleep is characterised by low muscular activity (Rechtschaffen & Kales, 1968). The classification of these sleep stages have since been revised by the American

Academy of Sleep Medicine (AASM), with the removal of ‘movement time’ and the combination of NREM Stages 3 and 4 (Iber, Ancoli-Israel, Chesson, & Quan, 2007).

Throughout children’s development, substantial changes in children’s sleep structure have been observed. A review of the literature by Tesler, Gerstenberg, and Huber (2013) highlights that, while the number of hours spent asleep decreases throughout development (from infancy to adolescence), the proportion of sleep time spent in the REM stage decreases and the proportion of sleep time spent in the NREM stage increases. Longitudinal data has also shown a reduction in sleep duration during the early years of children, as well as an increase in sleep duration at weekends for children from the age of 9, peaking during adolescence (Thorleifsdottir, Björnsson, Benediktsdottir, Gislason, & Kristbjarnarson, 2002), and daytime sleepiness was also found to increase during adolescence (Sadeh, Raviv, & Gruber, 2000; Thorleifsdottir et al., 2002). In addition, slow wave activity during NREM sleep appears to be related to brain maturation, with the amplitudes of slow waves increasing during childhood, peaking at puberty, and declining again during adolescence (Tesler et al., 2013).

Sleep problems can be defined as difficulties that interfere with children’s ability to achieve an optimum amount of sleep, and which parents deem to be problematic. There are two types of sleep problem: dyssomnias, which include difficulties initiating or maintaining sleep, or excessive daytime sleepiness; and parasomnias, which include events that disrupt sleep after sleep onset, such as arousal, sleepwalking, nightmares, or sleep terrors (K. Davis, Parker, & Montgomery, 2004). Parasomnias tend to only be experienced in younger children, with improvements generally seen over time (K. Davis et al., 2004). Results from a longitudinal study similarly suggest that sleep problems, including initiating and maintaining sleep, sleep-wake transition disorder, sleep hyperhidrosis, and disorders of excessive somnolence, reduced from pre-school to school aged children (Simola et al., 2012). However, 35% of the children who had sleep disturbances (including initiating and maintaining sleep, sleep breathing disorders, disorders of arousal, sleep-wake transition disorders, sleep hyperhidrosis, and

disorders of excessive somnolence) at pre-school age, were found to maintain these sleep problems at school age (Simola et al., 2012). Likewise about 60% of children with difficulties initiating sleep at age 9 continued to report these difficulties a year later (Fricke-Oerkermann et al., 2007). These findings suggest that sleep problems can be fairly persistent in children.

Sleep problems are often experienced alongside other psychological disorders, including anxiety and depression. Although widely considered as secondary to other psychological disorders (Billiard & Bentley, 2004; Harvey, 2001), some researchers argue that sleep problems should be considered as primary disorders in themselves (Harvey, 2001; Spoormaker & Montgomery, 2008). Billiard and Bentley (2004) suggest that it is not possible to consider insomnia (or other sleep problems) as a primary disorder when present with comorbid psychiatric symptoms, given the strong associations between sleep problems and psychiatric disorders. On the other hand, Spoormaker and Montgomery (2008) argue that it is not helpful to view sleep problems as a secondary disorder (in relation to post-traumatic stress disorder, PTSD), particularly given research evidence to suggest that many of the sleep problems associated with PTSD actually precede and are a risk factor for the development of PTSD, and remain a complaint following remission of PTSD symptoms. In addition, it may be important to consider sleep problems as primary disorders to ensure that symptoms are not trivialised and that optimum clinical interventions and treatments are made available to individuals suffering from sleep problems (Billiard & Bentley, 2004; Harvey, 2001; Spoormaker & Montgomery, 2008). Harvey (2001) highlights the issue that, while comorbid psychological disorders (such as anxiety and substance abuse) are usually both treated, insomnia and other sleep problems are typically considered as secondary to other psychological disorders. It is also assumed that insomnia would improve through treating the primary disorder, although this is not always the case (Harvey, 2001).

Unlike sleep problems, which could be considered a primary disorder, *sleepiness* is best defined as a symptom, whether of a sleep problem, or due to a disruption of the interaction

between the circadian and homeostatic processes that regulate sleep. For instance, sleepiness has been found to be associated with children's sleep onset time, with children who have later sleep onset found to report more sleepiness (Sadeh et al., 2000), and 10-19 year old children who napped during the day and reported greater daytime sleepiness were found to have significantly shorter sleep duration compared to those who did not nap or report daytime sleepiness (Thorleifsdottir et al., 2002).

### 1.1.5 Anxiety and Sleep

Common sleep problems that are comorbid with childhood anxiety include nightmares, trouble sleeping, and being over-tired (Alfano et al., 2006; Coulombe, Reid, Boyle, & Racine, 2011), as well as more awakenings and greater sleep latency (Forbes et al., 2008; Hansen, Skirbekk, Oerbeck, Richter, & Kristensen, 2011; Hudson, Gradisar, Gamble, Schniering, & Rebelo, 2009), less slow-wave sleep (Forbes et al., 2008), and greater sleep anxiety, bedtime resistance and daytime sleepiness (Hansen et al., 2011). In addition, anxious children may go to bed later, and have about half an hour less sleep compared with non-anxious children (Hudson et al., 2009), although it is not clear from this research whether this is a cause or effect of the child's anxiety. Younger children and girls with anxiety disorders show greater sleep problems than older children and boys with anxiety disorders (Alfano et al., 2010).

In a review of the literature exploring childhood anxiety with comorbid sleep problems, Chorney, Detweiler, Morris, and Kuhn (2008) report that difficulty falling asleep and maintaining sleep, nightmares and bed-wetting were common sleep problems for children with a diagnosis of post-traumatic stress disorder, while refusal to sleep has been associated with separation anxiety disorder. Insomnia is the most common sleep problem for children suffering from generalised anxiety disorder, although sleep disturbances and trouble sleeping have similarly been found to affect children with this disorder (Chorney et al., 2008). Less is currently known about common sleep problems for children with panic disorder, social anxiety disorder and obsessive-compulsive disorder (Chorney et al., 2008).

Research suggests that sleep problems in children with anxiety disorders persist across an 18-month time period, with 76% of children with anxiety disorders found to still have sleep problems 18 months after initial testing (Hansen, Skirbekk, Oerbeck, Wentzel-Larsen, & Kristensen, 2013). However, sleep problems for children in the control group (who reported sleep problems above the clinical cut-off) were also found to persist over this period, with 50% found to maintain their symptoms (Hansen et al., 2013), which may suggest that sleep problems, regardless of anxiety diagnoses, tend to persist over time.

Increased levels of sleepiness and sleep/wake problems from baseline to three years later predicted more symptoms of anxiety at the three year follow-up, compared to children with rapid reductions in sleepiness and sleep/wake problems, or no changes in sleepiness or sleep/wake problems from baseline to three years (El-Sheikh, Bub, Kelly, & Buckhalt, 2013). Findings from other longitudinal studies suggest that sleep problems during childhood predict anxiety disorders in later adolescence (Gregory & O'Connor, 2002; Ong, Wickramaratne, Tang, & Weissman, 2006) and in adulthood (Gregory et al., 2005), with this particularly being the case for children identified as sleeping less than their peers (Gregory, Van der Ende, Willis, & Verhulst, 2008). In addition, individuals with sleep problems during childhood were found to be over four times as likely to have highly persistent internalising problems, including anxiety, 18 years later (Touchette et al., 2012). Although these studies relied on self-reports of sleep problems, similar results have also been found using polysomnography or actigraphy, which are more objective measures of children's sleep. Polysomnography involves placing electrodes and monitors on the individual during sleep to record, for example, heart rate, breathing, oxygen levels, time taken to fall asleep, and time taken to enter rapid-eye movement sleep (National Institute of Health, 2014). Actigraphy is an alternative objective measure of sleep which, unlike polysomnography, can be used within the natural sleeping environment. Actigraphs are usually worn on the wrist, and record movements to estimate sleep parameters and habits (Martin & Hakim, 2011). However, actigraphy is less effective than polysomnogrpahy at validly estimating sleep latency, although  can be a useful indicator of sleep patterns and of certain

sleep problems (Martin & Hakim, 2011). In a study using polysomnography, children aged 6-12 years who were found to sleep for less than 7.5 hours per night at baseline were three times more likely to be anxious five years later, compared to those who slept for more than nine hours per night (Silva et al., 2011). Although it is anticipated that the associations between sleep problems and anxiety are bidirectional, there is currently more empirical support to suggest that earlier sleep problems are a risk factor for the later development of childhood anxiety disorders (Leahy & Gradisar, 2012). For instance, the little evidence available for anxiety symptoms being associated with the later development of sleep problems has relied mainly on retrospective reports, which have questionable reliability due to being determined by individuals' memories over, in some cases, long periods of time. On the other hand, evidence in support for sleep problems preceding the development of anxiety has used prospective longitudinal designs, which tend to provide more reliable indications of the direction of effect (Leahy & Gradisar, 2012).

### 1.1.6 Sleep and cognitive processing

Sleep is important for a number of cognitive processes, and when sleep was limited to 6.5 hours per night across five consecutive nights, it was shown to negatively affect memory, attention and arousal in a sample of adolescents (Beebe, Rose, & Amin, 2010). However, this study was based on a very small sample ($N$ = 16), and so the results need to be interpreted with caution. Similarly though, and based on a larger sample, as little as an extra hour of sleep over three consecutive nights improved children's memory, reaction times and performance on a variety of neurobehavioural functioning tasks compared to their responses at baseline, including digit recall tasks, reaction time tasks, and a continuous performance task in which children responded as quickly as possible to a particular animal, and avoided responding to other animals (Sadeh, Gruber, & Raviv, 2003). On the other hand, an hour less sleep deteriorated children's reaction time performance and levels of alertness compared to their baseline responses (Sadeh et al., 2003). Likewise, another study found a significant effect of an hour less sleep over a period of four consecutive nights on children's short-term memory, working memory, attention, and

speed and accuracy in working out maths problems, with poorer scores found for each of these cognitive functions for children who slept an hour less than usual compared to those who slept an hour longer than usual (Vriend et al., 2013). Although the studies described here suggest that *reduced sleep* affects children's cognitive functioning, there is currently little research that explores whether children's *current states of sleepiness* similarly affect their cognitive functioning. Although Vriend et al. (2013) did assess children's sleepiness, the sleepiness measures used were based on only one item each for parent, child, and researcher ratings of sleepiness, and the study did not explore the effect of sleepiness on children's cognitive functioning.

A substantial amount of evidence suggests that high order and complex cognitive functioning are significantly compromised for children receiving insufficient sleep. For example, in a large meta-analysis drawing on data from 86 studies and almost 36,000 children, executive functioning (including children's ability to adapt, inhibit responses, plan, and think creatively), as well as school performance and tasks using multiple-domain cognitive functioning, were found to be significantly impaired for children with shorter sleep duration (Astill, Van der Heijden, Van Ijzendoorn, Marinus, & Van Someren, 2012). In addition, a review of sleep and memory research in children suggests that sleep, and particularly quality of sleep, is critical for memory encoding, working memory processes and for memory consolidation, with some evidence to suggest that sleep was most beneficial for these processes when taken a few hours after learning (Kopasz et al., 2010). Similarly, sleep deprivation during the encoding phase of memory formation in adults was found to be associated with greater susceptibility to forming false memories (Frenda, Patihis, Loftus, Lewis, & Fenn, 2014), suggesting that sleep deprivation may interfere with accurate memory encoding. In Frenda et al.'s (2014) study, giving false information about a video scenario increased sleep deprived participants' susceptibility to forming false memories of the scenario, compared to participants who were not sleep deprived. However, this was only the case when participants were sleep deprived during the memory encoding phase, with participants who received the sleep

deprivation after they had encoded the memory not found to be as susceptible to the false memories (Frenda et al., 2014).

Based on the system consolidation theory that memories are selectively reactivated during sleep so that they can be consolidated and transferred to long-term memory (Born & Wilhelm, 2012), it seems plausible that sleep problems, including sleep deprivation, could interfere with this process. Similarly, if sleep deprivation can lead to the formation of false memories (Frenda et al., 2014), it is also possible that sleep deprivation and sleep problems may lead to exaggerated memories of emotionally reactive events, such as exposures to frightening stimuli. Indeed, sleep plays an important role in regulating emotional brain reactivity, with over-night sleep found to be important for the processing of emotional experiences and brain reactivity during the day, in preparation for emotional challenges to be faced the following day (Walker, 2009). In research using an adult sample, sleep has been shown to play an important role in memory consolidation for emotionally arousing stimuli (but not for neutral stimuli), with greater recognition accuracy shown for participants who slept following exposure to the task compared to when participants stayed awake following the task (Hu, Stylos-Allan, & Walker, 2006). However, this study was underpowered, which may explain the non-significant finding for the effect of sleep on recognition accuracy of neutral stimuli. On the other hand, the results do suggest that sleep may, at the very least, have an effect on the recognition of emotionally arousing stimuli.

It is, therefore, plausible that sleep may also play a role in cognitive processes related to anxiety disorders. For instance, sleep may promote retention of learning during exposure therapy. Following a simulated exposure therapy task, spider-fearful adults who stayed awake following the initial exposures to a spider showed an increase in fear ratings and skin conductance response to the spider when re-exposed 12-hours later (Pace-Schott, Verga, Bennett, & Spencer, 2012). On the other hand, participants who slept normally following the initial exposure showed a decrease in their skin conductance responses at the later exposure to

the spider (Pace-Schott et al., 2012). Thus, those who did not sleep between the exposure sessions were less successful in maintaining the benefits of their earlier exposures to the spider stimuli. However, this wakeful period following exposures to the spider was conducted during the day, with the initial exposure in the morning and the second exposure in the evening, whereas those in the sleep condition slept as usual at night, with the initial exposure in the evening (before sleep) and the second exposure the following morning. Therefore, the wake and sleep conditions may not be directly comparable. On the other hand, this study does demonstrate the benefits of normal sleep in the processing of exposures to scary stimuli, which suggests that an exploration of the role of reduced sleep and sleepiness on outcomes for anxious individuals may be warranted.

Other findings from Pace-Schott et al.'s (2012) research suggests that sleep not only promotes retention of learning, but may also promote the generalisation of learning during exposure therapy to similar stimuli. For instance, those who remained awake between the sessions did not generalise their learning to a novel spider, with their ratings for the novel spider being more negative in comparison to their initial ratings of the spider used in the exposure sessions. On the other hand, those who slept did not rate the novel spider more negatively than the spider used in the exposure settings (Pace-Schott et al., 2012). Similar effects were found when conducted within a controlled laboratory setting. Healthy adults, conditioned to fear two stimuli (through receipt of mild shocks) prior to engagement in extinction learning for one of these stimuli, were found to show greater generalisability of their learning from the extinction training to the other stimulus if they had slept following the extinction phase, compared to those who had not slept (Pace-Schott et al., 2009).

Findings from the child literature suggest that increased awakening during the night, and decreased sleep efficiency, predicted more errors in information processing of emotional facial expressions (Soffer-Dudek, Sadeh, Dahl, & Rosenblat-Stein, 2011). In this study, children engaged in a face-processing task, which included both emotion-processing and gender-

processing of faces. While children with greater sleep problems (that is, greater night-time awakening, and poor sleep efficiency) made a greater number of errors in the emotion-processing task compared to children with lower sleep problems, no difference was found between children with and without sleep problems for the gender-processing task (Soffer-Dudek et al., 2011). Sleep restriction has similarly been found to affect children's emotional responses and functioning (Berger, Miller, Seifer, Cares, & LeBourgeois, 2012; Vriend et al., 2013), although this research is based on relatively small sample sizes. For instance, when children went to bed an hour later than usual for four consecutive nights, compared to when they went to bed an hour earlier than usual for the same period, they were found to show less positive affect (in terms of feelings of happiness or interest) towards visual stimuli, and parents reported the children to have poorer emotion regulation, including the children's ability to calm down when angry (Vriend et al., 2013). Similarly, infants who had a sleep restriction (no afternoon nap) for five consecutive days showed less positive emotion displays (including pride and joy) when completing a puzzle compared to when they had taken their afternoon nap (Berger et al., 2012). During an unsolvable puzzle, the same infants were less engaged in the task and showed significantly more worry and anxiety when sleep-restricted compared to when they had taken a nap (Berger et al., 2012).

Surprisingly, although there is substantial evidence that suggests that sleep is very important for children's cognitive functioning (for example, Astill et al., 2012; Beebe et al., 2010; Kopasz et al., 2010; Sadeh et al., 2003), there is relatively little research considering the role of sleep on children's emotional cognitive processes, and none, to the author's knowledge, that explore the role of sleepiness on these, and other, anxiety-related processes.

## 1.2 The Current Research

There is substantial evidence to suggest that sleep is very important in children's cognitive functioning, with sleep problems in children affecting a range of cognitive processes, including attention, learning, arousal (Beebe et al., 2010), reaction times (Sadeh et al., 2003), memory

(Kopasz et al., 2010; Sadeh et al., 2003), and executive functioning (Astill et al., 2012). With this evidence, and given the strong associations found between sleep problems and anxiety (Alfano et al., 2007; Chase & Pincus, 2011), it seems plausible that childhood sleep problems may affect the cognitive and behavioural processes associated with childhood anxiety. It is also possible that children's *states of sleepiness*, in addition to sleep problems, may similarly be associated with childhood anxiety, and affect these anxiety-related processes. There is currently scarce research considering the relationship between child sleepiness and anxiety, with research focusing instead on child sleep *problems*. However, if children's states of sleepiness affect their emotional processing ability, and are associated with negative cognitions and greater avoidance of anxiety-relevant situations and stimuli, then this would hold important clinical implications for the treatment of childhood anxiety disorders. This thesis will address this gap in the literature by exploring associations between child *sleepiness* and anxiety, and considering whether child sleepiness and sleep problems are associated with, and affect, a variety of anxiety-related cognitive and behavioural processes, including ambiguity resolution, emotion recognition, avoidance and habituation. The thesis will also consider associations between child sleepiness and sleep problems on children's vicarious learning experiences. As cognitive-behavioural therapy is the current treatment of choice for childhood anxiety disorders (Manassis, 2013; Reynolds et al., 2012), the thesis begins with a meta-analysis of the efficacy of transdiagnostic CBT for children with anxiety disorders, and the thesis also considers the impact of child sleep problems on the outcomes of a cognitive-behavioural treatment for children with anxiety.

# Chapter 2: Paper 1 - A Meta-Analysis of Transdiagnostic Cognitive Behavioural Therapy in the Treatment of Child and Young Person Anxiety Disorders

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## 2.1 Abstract

**Background:** Previous meta-analyses of cognitive-behavioural therapy (CBT) for children and young people with anxiety disorders have not considered the efficacy of transdiagnostic CBT for the remission of childhood anxiety. **Aim:** To provide a meta-analysis on the efficacy of transdiagnostic CBT for children and young people with anxiety disorders. **Methods:** The analysis included randomised controlled trials using transdiagnostic CBT for children and young people formally diagnosed with an anxiety disorder. An electronic search was conducted using the following databases: ASSIA, Cochrane Controlled Trials Register, Current Controlled Trials, Medline, PsycArticles, PsychInfo, and Web of Knowledge. The search terms included 'anxiety disorder(s)', 'anxi*', 'cognitive behavio*', 'CBT', 'child*', 'children', 'paediatric', 'adolescent(s)', 'adolescence', 'youth', and 'young pe*'. The studies identified from this search were screened against the inclusion and exclusion criteria, and 20 studies were identified as appropriate for inclusion in the current meta-analysis. Pre- and post- treatment (or control period) data were used for analysis. **Results:** Findings indicated significantly greater odds of anxiety remission from pre- to post- treatment for those engaged in the transdiagnostic CBT intervention compared with those in the control group, with children in the treatment condition 9.15 times more likely to recover from their anxiety diagnosis than children in the control group. Risk of bias was not correlated with study effect sizes. **Conclusions:** Transdiagnostic CBT seems effective in reducing symptoms of anxiety in children and young people. Further research is required to investigate the efficacy of CBT for children under the age of six.

## 2.2 Introduction

Considerable interest in childhood anxiety disorders has emerged, which R. Klein (2009) attributes to their prevalence, economic and medical cost, and the early onset of anxiety disorders in comparison to other mental health difficulties. Prevalence of anxiety disorders in children and young people is relatively high, although a meta-analysis has indicated that there is a wide range of prevalence rates (from 3.05% to 23.9%) across studies (Cartwright-Hatton et al.,

2006). Children are affected by a range of anxiety disorders, including generalised anxiety disorder, social phobia, panic disorder, agoraphobia, and separation anxiety disorder (R. Klein, 2009). Boys have been found to develop anxiety disorders at a younger age compared with girls, with 7-12 year old boys and adolescent girls (aged 13-19 years) being more frequently referred for treatment than boys and girls in other age groups (Hoff Esbjørn, Hoeyer, Dyrborg, Leth, & Kendall, 2010). Overall though, the prevalence of anxiety disorders tends to increase with age (Hoff Esbjørn et al., 2010; Kendall et al., 2010).

Cognitive-behavioural approaches assume that anxiety is maintained through safety behaviours and avoidance (Hofmann, 2007), as well as through worrying, causal attributions, and memory processes (Prins, 2001). Compared with adults, children are assumed to be more threatened by anxiety-provoking situations and to feel less confident in their ability to cope with the situation (Prins, 2001). CBT has been developed to treat anxiety disorders in children and young people, with techniques of '*cognitive restructuring, coping self-talk, in vivo exposure, modelling, and relaxation training*' (Muris, Mayer, den Adel, Roos, & van Wamelen, 2009, p.14).

Meta-analyses are a useful way of drawing together a number of studies that test similar questions, such as the efficacy of treatments for psychological disorders. Individual studies based on small samples are likely to suffer more bias than large-sample studies, but a meta-analysis makes use of the data from a number of studies, thus reducing this risk of bias (Field & Gillett, 2010). In addition, it is possible to test the variability in effect sizes between the studies using a meta-analysis (Field & Gillett, 2010).

Reviews of the literature examining the efficacy of treatments for anxiety in children suggest that CBT is a 'probably efficacious' or 'well-established' intervention for a variety of childhood anxiety disorders, including specific phobias, social phobia, obsessive compulsive disorder (OCD), and post-traumatic stress disorder (PTSD) (Compton et al., 2004; T. E. Davis, May, & Whiting, 2011). A recent meta-analysis indicated that the efficacy of CBT is not moderated by age, with children and adolescents demonstrating similar benefits from the

treatment, although the authors of that analysis acknowledge that modifications carried out on the CBT may explain this finding (Bennett et al., 2013).

CBT for disorders such as OCD, PTSD, social anxiety disorder and specific phobias tends to be adapted according to the specific anxiety disorder that is being treated. For example, Spence, Donovan, and Brechman-Toussaint (2000) adapted CBT for children with social anxiety disorder by placing an emphasis on social skills training, and Williams et al. (2010) adapted CBT for children with OCD by targeting cognitions specific to OCD. Whilst CBT that is adapted for these conditions might be effective for those specific diagnoses (Cohen & Mannarino, 1996, 1998; Spence et al., 2000; Williams et al., 2010), many general Child and Adolescent Mental Health Services (CAMHS) will not have the skills or throughput of clients to provide specialised interventions for each of the anxiety disorders. Moreover, given the very high level of comorbidity amongst the anxiety disorders of childhood (Leyfer, Gallo, Cooper-Vince, & Pincus, 2013), a more generic, or transdiagnostic, approach is often more practical. And indeed, children are usually offered a transdiagnostic CBT package, which aims to address the common elements of all anxiety disorders (in particular, avoidance, anxiogenic cognition, and sometimes anxiogenic parenting). A question which remains currently unanswered is whether transdiagnostic CBT is beneficial to children and adolescents with anxiety disorders. This study presents a meta-analysis of studies that treat anxious children using transdiagnostic CBT interventions that are intended for the whole range of childhood anxiety disorders.

Other meta-analyses have found CBT to be efficacious in treating childhood anxiety disorders, but do not answer the present question, for a number of reasons: Some have included studies of CBT that have been adapted to treat a specific anxiety disorder such as OCD, social anxiety disorder and PTSD (Cartwright-Hatton et al., 2004; Ishikawa, Okajima, Matsuoka, & Sakano, 2007; Silverman, Pina, & Viswesvaran, 2008), or have not used diagnostic outcome measures of the children's anxiety disorder (In-Albon & Schneider, 2007). Others included non-CBT treatments within the meta-analysis, such as eye-movement desensitisation and reprocessing therapy (EMDR), and exposure and response prevention therapy (ERP) (Reynolds

et al., 2012; Silverman et al., 2008) or included studies using 'treatment elements' of CBT (such as behavioural treatments or social effectiveness training instead of transdiagnostic CBT) (Ishikawa et al., 2007) and were therefore unable to answer the question as to whether transdiagnostic CBT was an efficacious treatment for children and adolescents with anxiety disorders. A meta-analysis undertaken by James, James, Cowdrey, Soler, and Choke (2013) included studies in which anxiety disorders were not always the primary diagnosis (for instance, they included studies by Chalfant, Rapee, and Carroll (2007), McNally Keehn, Lincoln, Brown, and Chavira (2013) and Wood et al. (2009), which considered the efficacy of CBT for children with autistic spectrum disorders and comorbid anxiety, and a study by Masia-Warner et al. (2011) which considered children with primary somatic complaints).

The current meta-analysis intends to fill this gap in the literature by exploring the efficacy of transdiagnostic CBT for the remission of children and young people's anxiety disorder diagnoses at post-treatment. In addition, the current review sought to investigate whether recent research had been conducted for children under the age of six, following the assertion by Cartwright-Hatton et al. (2004) that this was an area lacking in research evidence.

## 2.3 Inclusion criteria

The following inclusion criteria were used for the review:

(a) The study was a randomised controlled trial

(b) The sample included children and young people up to the age of 18 at the time of entry into the study

(c) Participants had a primary clinical diagnosis of an anxiety disorder, formally assessed as part of the trial

(d) The intervention was CBT

(e) Interventions used non-active controls (defined as those given no treatment or who were placed in a wait-list control)

(f) Anxiety diagnosis outcome data was available at post-treatment

(g) Reports of research were published in English

(h) The sample size of the study was greater than 1

## 2.4 Exclusion criteria

Trials were excluded from the analysis if:

(a) They didn't specifically treat anxiety disorders or exclusively treated a single anxiety disorder (studies treating just OCD, PTSD, social anxiety disorder or specific phobias, were found but excluded).

(b) They only used self-report outcome measures. The exclusion of self-report outcome measures was necessary since the aim of the current meta-analysis was to measure change in clinical diagnosis following the intervention, which cannot be assessed by self-report measures.

(c) They employed active controls. These were excluded since few studies with comparison interventions were found, and where available, the comparison interventions frequently included cognitive-behavioural elements.

(d) Parent-only interventions were used which meant that children were not involved in the treatment.

## 2.5 Method

A search was initially conducted to ensure that all trials included in previous meta-analyses were considered for eligibility for the current meta-analysis. A search was then conducted to include other relevant trials, up to and including July 2012. The following electronic databases were used to search for appropriate trials: Applied Social Sciences Index and Abstracts (ASSIA); Cochrane Controlled Trials Register; Current Controlled Trials; Medline; PsycArticles; PsycInfo; and Web of Knowledge. A text search was conducted for keywords, taking into consideration synonyms, variant spellings (such as 'behaviour' versus 'behavior'), and plurals (such as 'child' versus 'children'). The search terms used were: 'anxiety disorder(s)' OR 'anxi*' AND 'cognitive behavio*' OR 'CBT' AND 'child*' OR 'children' OR 'adolescent(s)' OR 'adolescence' OR 'youth' OR 'young pe*' OR 'paediatric'.

The titles and abstracts of the articles generated by the search were screened to assess their applicability to this meta-analysis. The full text was downloaded and screened for those studies that appeared to meet the inclusion criteria. Details of the study design were extracted to ensure that the design met the inclusion criteria for the review and those not meeting the criteria were excluded. Further details were then extracted from the remaining articles including type of anxiety disorder, age of participants, experimental and control conditions, diagnostic outcome measures used, exclusion criteria and outcome of the intervention. To minimise the risk of publication bias, the authors of papers both included and excluded in this analysis were contacted to identify any relevant unpublished manuscripts that should be considered.

### 2.5.1 Search Results

The search identified 117 trials that required consideration for this meta-analysis, including those trials used in previous meta-analyses. The studies were checked against the inclusion criteria, which resulted in the exclusion of 97 studies (please refer to Appendix 1 for the references of the included and excluded studies). Twenty studies remained for analysis (see Appendix 2). The flow diagram of the search results (in the format recommended by Moher, Liberati, Tetzlaff, & Altman, 2009) is displayed in Figure 2.1.

Excluded studies often met more than one criterion for exclusion. One study was excluded for not meeting the criteria of using a sample of children and young people up to the age of 18, and another was excluded for not being a randomised controlled trial. Twenty-nine studies were excluded for not using CBT (or a non-adapted CBT) as the treatment method, and two studies were excluded for using parent-only CBT methods. Four studies were excluded for not being published in English. Twelve studies were excluded for not using a sample of children and young people with clinically diagnosed anxiety disorders, and one study was excluded for not using pre-waitlist diagnostic criteria. Twenty studies were excluded for not using a diagnostic outcome measure of anxiety, and a further four were excluded for not having post-treatment data available for analysis (only follow-up data was available). Nineteen studies were excluded for exclusively treating either OCD, PTSD, social anxiety disorder or a specific

phobia. A further seven studies were excluded as the studies did not relate directly to the treatment of anxiety disorders. Finally, thirty-six studies were excluded because they did not use a control group or used an active control group. All studies used a sample size greater than 1.

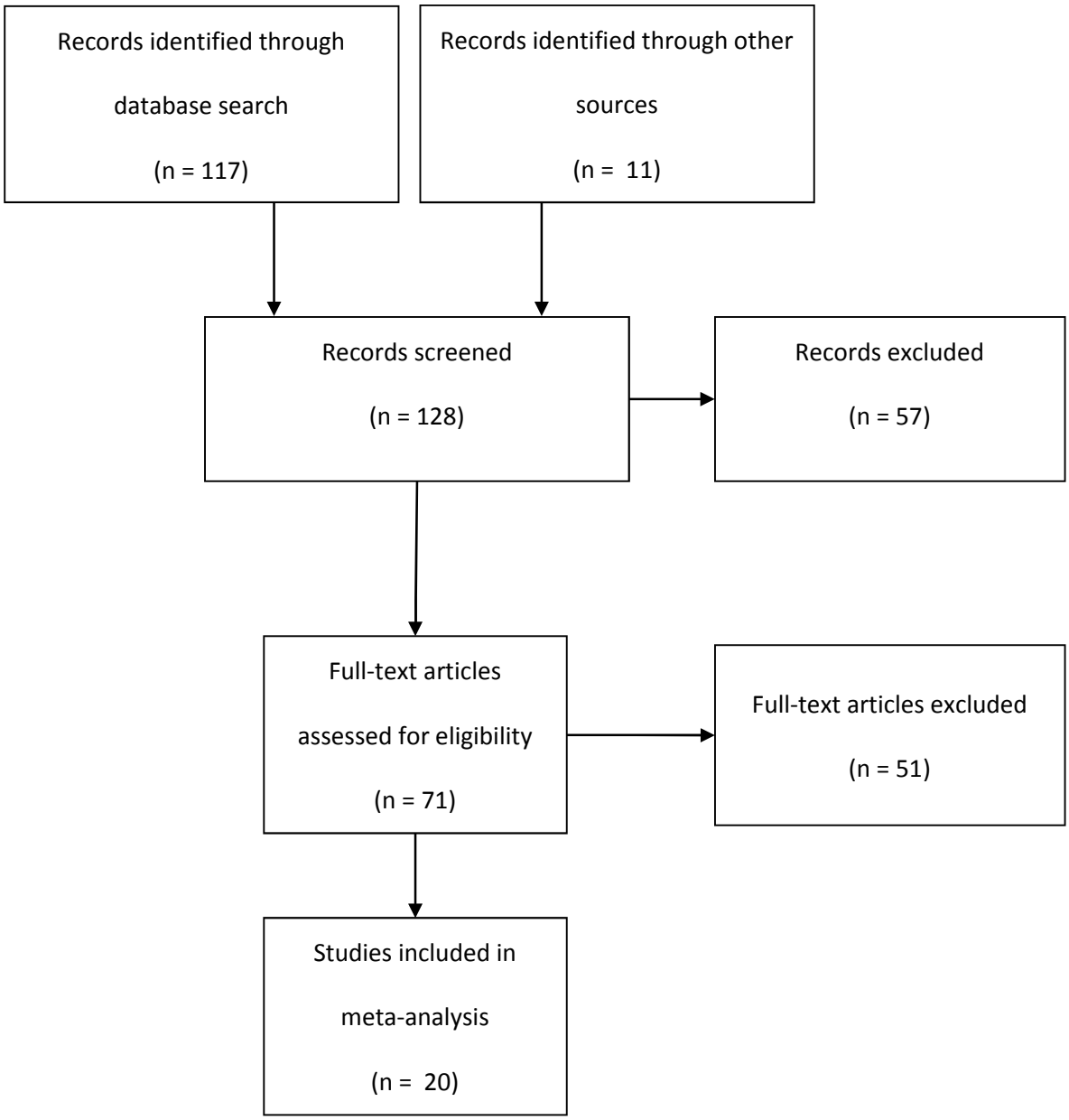


*Figure 2.1: Flow-diagram of search results*

In addition to the 117 trials identified by the database search, twenty-six authors were contacted about unpublished data suitable for consideration in this meta-analysis. These authors were provided with the inclusion and exclusion criteria for this meta-analysis to help them

identify any relevant unpublished data. Sixteen of these responded confirming that there were no unpublished manuscripts to consider. One author suggested a paper under review, but this was excluded because it lacked a control group. A further nine published papers were offered for consideration, but none of these fully met the inclusion criteria and were excluded from the analysis. Two of these papers did not use a control group, three examined long-term follow-up only, two did not include clinical anxiety diagnoses, one examined mediator effects rather than the efficacy of the intervention, and one study only included children with OCD.

### 2.5.2 Risk of Bias Assessment

To assess the risk of bias in the trials used in this meta-analysis, a modified version of the bias assessment form used in Cartwright-Hatton et al.'s (2004) paper (based on the form produced by the University of York, 2001) was used. This form lists the criteria expected of an ideal trial design, with studies assigned a score of 0-3 for each criterion. A score of 0 indicated that the trial did not meet any of the ideal aspects (or not enough information was provided to be scored) for that criterion; a score of 1 indicated that the trial met one ideal aspect; a score of 2 indicated that the trial met most ideal aspects; and a score of 3 indicated that all ideal aspects of the criterion had been met. The results of this assessment suggested that there was a moderate risk of bias, since not all criteria were sufficiently met (see Appendix 3). Two of the authors (D.E. and E.T.) independently rated the included trials for risk of bias, with double-ratings available for 85% of the studies. There was substantial inter-rater agreement across the criteria (Kappa range = 0.64 – 1.00).

### 2.5.3 Statistical Analysis

The log odds ratios for remission of anxiety following treatments were estimated for each study. The log odds ratio was chosen since it uses positive and negative values, thus creating a normal distribution of scores. However, the raw odds ratio can be skewed since it does not use negative values (Bland & Altman, 2000). A conservative analysis was used for the intent-to-treat cases which assumed successful remission for those not followed up from the waiting list condition,

and non-remission for those not followed up from the treatment condition. Different types of CBT method used within a study (e.g. group/individual/family) were pooled to provide an overall score for remission following transdiagnostic CBT. The meta-analysis was conducted using random effects methods and the Dersimonian-Laird estimate of between-study variability.

## 2.6 Results

### 2.6.1 Participant characteristics

Across the 20 studies appropriate for the current review, there was a total of 2,099 participants (Mean = 105 participants per study; range = 37 to 488), with 1,251 placed in the treatment conditions and 601 placed in control conditions (a further 243 participants were placed in comparison groups). For many of the studies, there was more than one CBT treatment condition (e.g. group, family and individual), which explains the larger number placed for treatment than for the wait-list.

The age range of participants was 4 – 18 years. However, very few studies used participants at the lower end of the range, with two studies including children from four years of age (and a further four studies including children from 6 years of age). The majority of studies considered children between the ages of 7-14, and five studies included children aged 15 years and over. It was not possible to explore pooled outcomes for independent age groups as overlapping ranges were used across studies.

Of the participants, 822 (30%) presented with (as their primary diagnosis) generalised anxiety disorder (GAD), 20 (1%) with panic disorder (PD), 634 (23%) with separation anxiety disorder (SAD), 440 (16%) with social phobia (SoP), 604 (22%) with specific phobia (SP), 21 (1%) with agoraphobia (AP), and 174 (6%) with over-anxious disorder (OAD). Many participants had more than one anxiety disorder diagnosis, which is reflected in these figures.

Table 2.1: Outcome data and odds ratios

| Study | CBT | | Waiting list | | Followed-up cases | | Intent-to-treat cases | |
|---|---|---|---|---|---|---|---|---|
| | WD | R/FU | WD | R/FU | Odds ratio (95% CI) | Log odds ratio | Odds ratio (95% CI) | Log odds ratio |
| Cobham (2012) | 0 | 18/23 | 2 | 0/12 | 86.4 (4.31 – 1730.98) | 4.46 | 25.2 (4.24 – 149.79) | 3.07 |
| Spence (2011) | 4 | 13/40 | 3 | 1/24 | 11.07 (1.34 – 91.21) | 2.40 | 2.41 (0.70 – 8.36) | 0.88 |
| Hirshfeld-Becker (2010) | 5 | 17/29 | 2 | 5/28 | 6.52 (1.93 – 22.01) | 1.87 | 3.29 (1.12 – 9.68) | 1.19 |
| Lau (2010) | 3 | 13/20 | 4 | 0/21 | 78 (4.08 – 1492.19) | 4.36 | 6.83 (1.77 – 26.33) | 1.92 |
| S. March (2009) | 10 | 9/30 | 4 | 3/29 | 3.71 (0.89 – 15.48) | 1.31 | 1.08 (0.353 – 3.29) | 0.08 |
| Waters (2009) | 15 | 39/49* | 0 | 2/11* | 17.55 (3.26 – 94.38) | 2.87 | 7.02 (1.40 – 35.20) | 1.95 |
| Bodden (2008) | 14 | 71/114 | 0 | 0/25 | 82.56 (4.90 – 1391.86) | 4.41 | 62.28 (3.71 – 1045.93) | 4.13 |
| Walkup (2008) | 19 | 196/279* | 15 | 18/76* | 7.61 (4.23 – 13.70) | 2.03 | 3.38 (2.07 – 5.51) | 1.22 |
| Rapee (2006) | 14 | 46/76 | 12 | 5/75 | 21.47 (7.76 – 59.37) | 3.07 | 5.04 (2.59 – 9.82) | 1.62 |
| Spence (2006) | 4 | 27/45 | 0 | 3/23 | 10 (2.59 – 38.66) | 2.30 | 8.18 (2.15 – 31.18) | 2.10 |
| Bernstein (2005) | 5 | 19/37 | 0 | 6/24 | 3.17 (1.03 – 9.77) | 1.15 | 2.48 (0.82 – 7.49) | 0.91 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Nauta (2003) | 0 | 32/59 | 0 | 2/20 | 10.67 (2.27 – 50.16) | 2.37 | 10.67 (2.27 – 50.16) | 2.37 |
| Shortt (2001) | 1 | 33/53 | 5 | 1/12 | 18.15 (2.18 – 151.38) | 2.90 | 2.88 (0.93 – 8.97) | 1.06 |
| Flannery-Schroeder (2000) | 6* | 17/31 | 0* | 0/12 | 29.14 (1.58 – 538.22) | 3.37 | 20.4 (1.12 – 371.46) | 3.02 |
| Silverman (1999) | 12 | 16/25 | 3 | 2/16 | 12.44 (2.29 – 67.56) | 2.52 | 2.13 (0.64 – 7.16) | 0.76 |
| Barrett (1998) | 6 | 25/34 | 4 | 4/16 | 8.33 (2.13 – 32.60) | 2.12 | 2.5 (0.83 – 7.51) | 0.92 |
| Kendall (1997) | 13* | 25/47* | 11* | 2/23* | 11.93 (2.51 – 56.75) | 2.48 | 1.15 (0.49 – 2.73) | 0.14 |
| Dadds (1997) | 1 | 27/41 | 1 | 27/52 | 1.79 (0.77 – 4.15) | 0.58 | 1.61 (0.70 – 3.69) | 0.47 |
| Barrett (1996) | 0 | 37/53 | 3 | 6/23 | 6.55 (2.18 – 19.68) | 1.88 | 4.37 (1.61 – 11.85) | 1.47 |
| Kendall (1994) | 2* | 16/25* | 0 | 1/20 | 33.78 (3.8 – 295.95) | 3.52 | 27.64 (3.21 – 237.83) | 3.32 |
| Pooled | 134 | 696/1110 | 69 | 88/542 | 8.62 (6.65 – 11.16) | 2.15 | 3.65 (2.95 – 4.52) | 1.29 |

*Data extrapolated from other information in the paper. *Notes:* WD = withdrawn; R/FU = recovery of those followed-up.

### 2.6.2 Meta-analysis

Table 2.1 shows the log odds ratios for remission from anxiety in each of the studies. The log odds ratios are also represented as forest plots[1] for completers and intent-to-treat samples in Figures 2.2 and 2.3.

Meta-analytic calculations were conducted, weighting the odds ratios according to the inverse of their variance. There was a positive, significant weighted mean effect size for the completer sample, LOR = 2.21; 95% CI = 1.80 – 2.63; SE = 0.21; $z = 10.37$, $p < .001$. The log odds ratio for the completer sample was exponentiated to allow interpretation of the odds ratio, OR = 9.15. Thus, the odds of recovery from an anxiety disorder was 9.15 times higher for those children in the transdiagnostic CBT treatment group compared to those children in the control group. The data were not homogenous, suggesting that there were between study differences, $\chi^2(20) = 31.85$, $p < .05$.

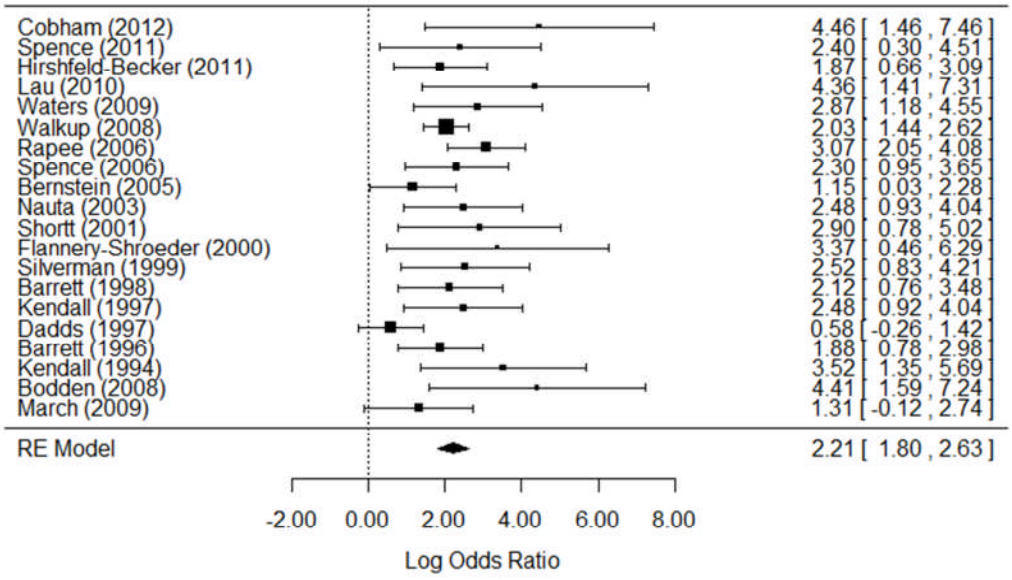


*Figure 2.2: Forest plot for the log odds ratios of the completer sample*

[1] The forest plot is a representation of the effect size for each study. The squares represent the mean effect size (the size of the square represents the weight of the study in this analysis), and the lines represent the confidence intervals. Effect sizes to the right of the vertical line at zero indicate a positive intervention effect.

The analysis was repeated for the intent-to-treat sample. There was a positive and significant weighted mean effect size for remission from anxiety for the intention to treat sample, suggesting that transdiagnostic CBT is successful in freeing children from their anxiety disorder diagnoses, LOR = 1.39; 95% CI = 0.98 – 1.79; SE = 0.21; $z = 6.71$, $p < .001$. The log odds ratio for the intent-to-treat sample was exponentiated to allow interpretation of the odds ratio, OR = 3.99. Thus, even after adopting a conservative intent-to-treat analysis, the odds of recovery from an anxiety disorder was 3.99 times higher for those children in the transdiagnostic CBT treatment group compared to those children in the control group. The data for this analysis were not homogenous, suggesting that there were between study differences, $\chi^2(19) = 43.36$, $p < .01$. However, the forest plots in Figures 2.2 and 2.3 suggest that the studies were not too dissimilar in both the completer and intent-to-treat samples, as all studies indicated a positive intervention effect and there was considerable overlap of confidence intervals across all of the studies.

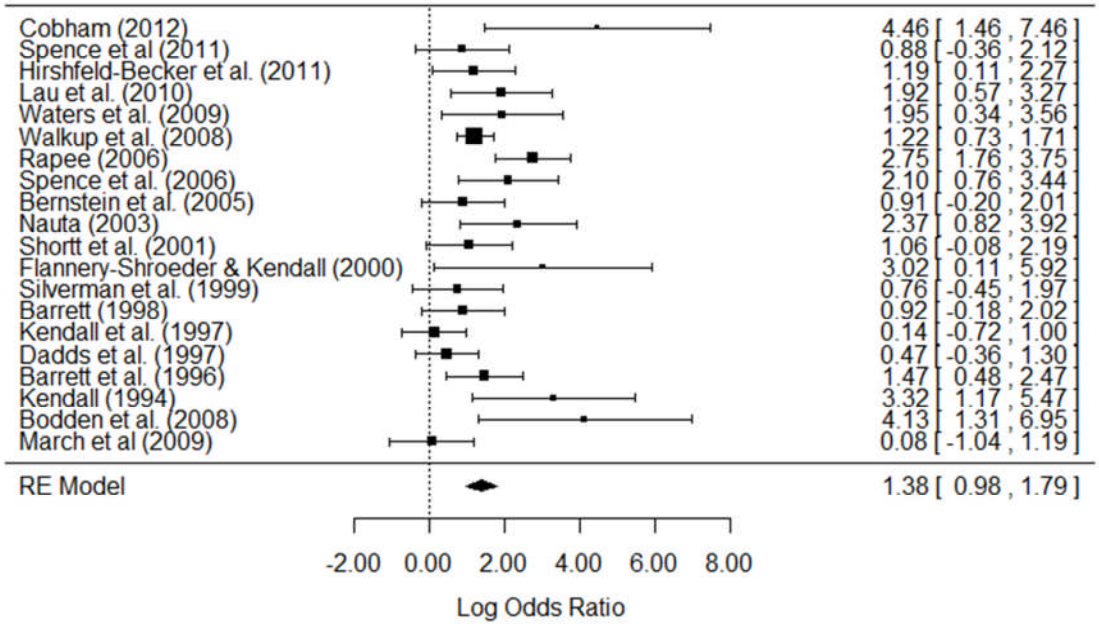


*Figure 2.3: Forest plot of the log odds ratios for the intent-to-treat sample*

### 2.6.3 Format of treatment delivery

To compare the efficacy of individual and group formats of CBT delivery, meta-analytic calculations were conducted separately for studies that adopted individual versus group formats. Ten studies used individual CBT formats, and eleven studies used group CBT formats (one study used both formats, which is represented in these numbers). There was no significant difference between the log odds ratios of studies adopting individual or group CBT formats for both followed up cases (individual LOR = 2.18 (95% CI = 1.79 – 2.57; OR = 8.83); group LOR = 2.20 (95% CI = 1.48 – 2.92; OR = 9.00)), and for intent-to-treat participants (individual LOR = 1.36 (95% CI = 0.77 – 1.94; OR = 3.88); group LOR = 1.36 (95% CI = 0.84 – 1.87; OR = 3.88)).

### 2.6.4 Risk of Bias

A correlational analysis was computed to investigate whether there was a relationship between odds ratio and risk of bias score. Results indicated no significant correlation between effect size and risk of bias score, $r = .03$, $p = .91$. A scatter plot of the relationship between these variables is shown in Figure 2.4.

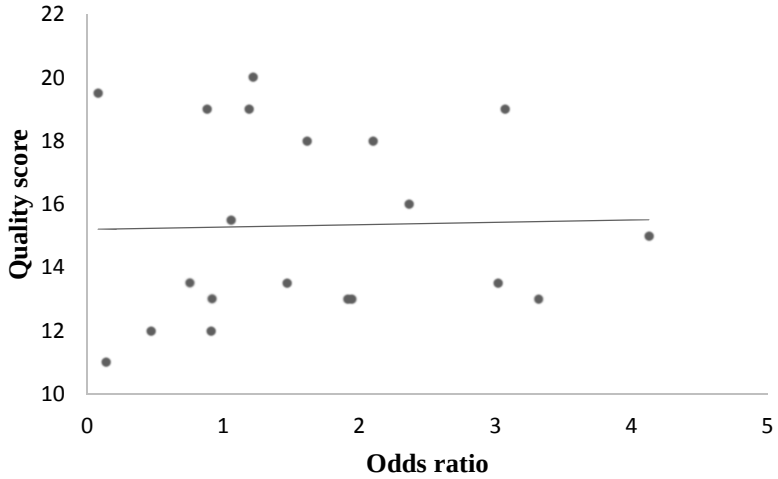


*Figure 2.4: Scatter plot for the relationship between odds ratios and quality scores for the trials used in the meta-analysis*

### 2.6.5 Publication Bias

Funnel plots for the effect sizes of both the completer and intent-to-treat samples were conducted to check for publication bias (Figures 2.5 and 2.6). Larger and therefore more precise studies with lower standard errors are expected to have odds ratios closer to the pooled estimate of the treatment effect (indicated by the vertical line through the tip of the funnel), whereas the odds ratios of smaller and less precise studies (higher standard errors) are expected to be more widely distributed around the pooled estimate, thus forming an inverted funnel shape (Cochrane Collaboration, 2002). The results of these funnel plots suggest that there may be an issue of publication bias given the asymmetrical shape of the plot, with no small scale studies with low odds ratios included in this analysis.

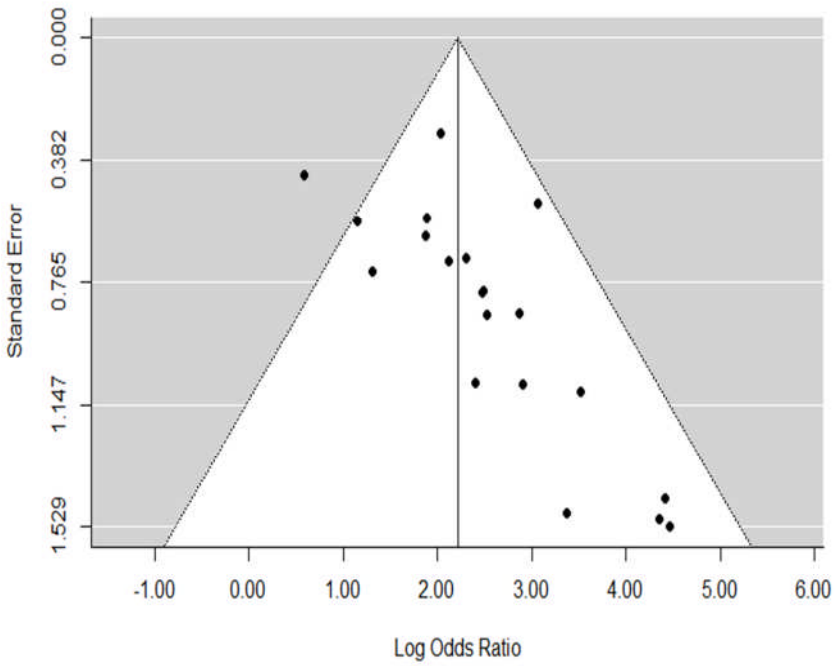


*Figure 2.5: Funnel plot of the log odds ratios for the completer sample*

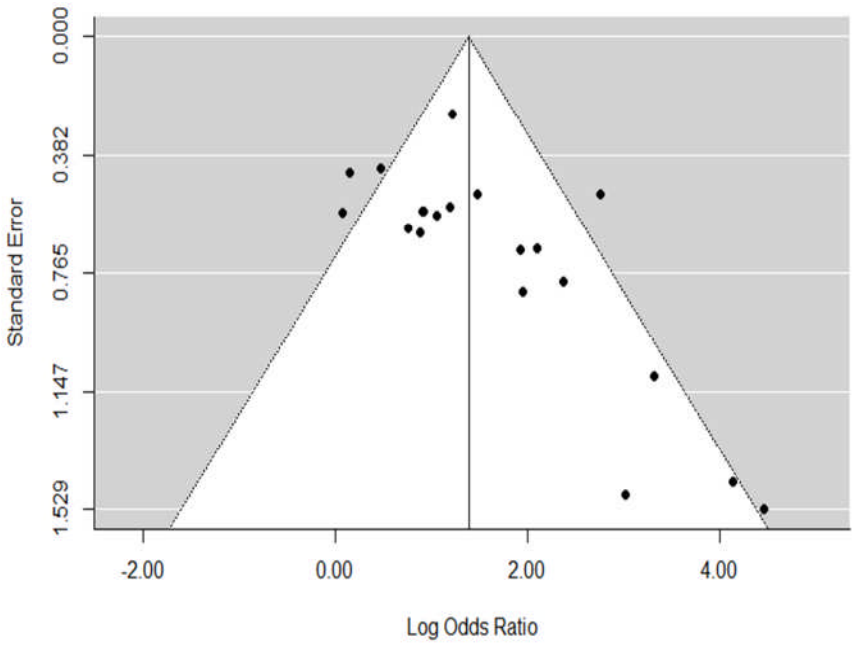


*Figure 2.6: Funnel plot of the log odds ratios for the intent-to-treat sample*

## 2.7 Discussion and conclusion

This meta-analysis provides an important update to the literature on the efficacy of transdiagnostic CBT for treating anxiety disorders in children and young people. The results suggest that transdiagnostic CBT is efficacious for the treatment of anxiety in this age group. The raw odds ratio scores indicated that for the conservative intent-to-treat sample, children in the transdiagnostic CBT group were 3.99 times more likely to remit from their anxiety disorder by post-treatment compared to children in the control group. For completers, children receiving transdiagnostic CBT were 9.15 times more likely to remit by post-treatment than children in the control group. These findings suggest that providing children with transdiagnostic CBT is very efficacious, and would therefore be a suitable alternative for when resources are unavailable to provide specific anxiety-disorder focussed interventions. Previous meta-analyses have generally included trials that adapt CBT according to different anxiety disorders, and so the results of this paper add to the literature by providing support for the use of a transdiagnostic CBT procedure for childhood anxiety disorders. In addition, given the recent changes to the Diagnostic and

Statistical Manual for Mental Health Disorders (DSM-5) which removed OCD and PTSD from the anxiety disorder chapter (APA, 2013), it is useful to have results for the efficacy of transdiagnostic CBT for the disorders that remain classified as anxiety disorders. Two of the papers included in this meta-analysis included participants with either PTSD (Cobham, 2012) or OCD (Rapee, Abbott, & Lyneham, 2006), but very few participants out of the sample had these disorders (PTSD, *n* = 1 out of 55 participants; OCD, *n* = 13 out of 267 participants) and so it is not expected that the inclusion of these papers has affected the results significantly.

The log odds of recovery found for the intent-to-treat sample of children engaged in transdiagnostic CBT was comparable to the log odds found by Ishikawa et al. (2007), who included studies using specific anxiety disorder focussed interventions (LOR = 1.23, converted from Cohen's d). This may suggest that transdiagnostic CBT is similarly effective as disorder-specific interventions for the treatment of childhood anxiety disorders. On the other hand, Reynolds et al. (2012) compared generic CBT with disorder-specific CBT and found only a moderate effect size for the effectiveness of generic CBT compared to a medium to large effect size for disorder-specific CBT. However, the disorder-specific CBT trials included different anxiety diagnoses than the generic CBT trials (for example, PTSD, social phobia, OCD, and specific phobias were used in the disorder-specific CBT trials, whereas separation anxiety disorder, social phobia and GAD were used in the generic CBT trials), which does not provide a like-for-like comparison and may explain this different result. In addition, the generic CBT trials used by Reynolds et al. (2012) included trials with social phobia diagnoses, yet these trials tend to additionally include social skills training. It is arguable, therefore, that the generic CBT referred to in Reynolds et al.'s (2012) paper is not purely transdiagnostic. Further research is needed to compare the efficacy of transdiagnostic CBT with CBT that has been tailored for specific anxiety disorders in children, so that conclusions can be drawn as to whether or not it is beneficial to adapt CBT procedures according to type of anxiety. Findings within the adult literature suggest that a transdiagnostic approach to treatment is equally as effective as a

disorder-specific treatment, particularly where comorbid disorders are also present (McManus, Shafran, & Cooper, 2010; Norton & Barrera, 2012).

There is a possibility that this meta-analysis is subject to publication bias, as indicated by the results of the funnel plots. However, this risk is considered to be minimal since key authors in the field were contacted to request unpublished articles, and many confirmed that they had no relevant papers to be included in this analysis. Similarly, it is possible that a bias was introduced by only including publications printed in English. Unfortunately resources were unavailable to include studies printed in alternative languages. The risk of bias assessment indicated a moderate risk of bias due to the methods adopted within the studies, which has the potential to lead to inflated effect sizes. However, there was no significant correlation between risk of bias and log odds ratio, which suggests that risk of bias does not significantly influence the conclusions drawn from the results of this meta-analysis.

A decision was made to exclude self-report measures in the current meta-analysis. A limitation of this choice is that beneficial effects of treatment that fell short of reaching clinical cut-offs may not have been recognised. However, the aim of the current analysis was to determine the efficacy of transdiagnostic CBT for helping children to be free from their anxiety disorder diagnosis, and it is only possible to measure this through the use of diagnostic measures.

The use of non-active control groups in the meta-analysis has the potential to inflate effect sizes. However, a decision was made to exclude active controls on the basis that most active control groups contained elements of CBT, which would invalidate a pure comparison of the effectiveness of CBT against controls. Given that this meta-analysis aimed to consider the efficacy of a pure, non-adapted form of CBT on the treatment of anxiety disorders, it seemed logical to also ensure that the control groups were ‘pure’ and contained no elements of CBT. Ideally, we now need randomised controlled trials that allocate control participants to an active control group free of cognitive-behavioural elements, although it is appreciated that designing such an intervention will be challenging.

In specifying inclusion and exclusion criteria, many authors of the papers included in this analysis chose to exclude participants with co-morbid disorders such as behavioural and emotional disorders, learning disabilities, or autistic spectrum disorders. Although their reasons for exclusion are valid, it may be useful for future research to consider the impact of these co-morbidities on the success of CBT. Evidence reported by Ginsburg et al. (2011) suggests that the presence of comorbid internalising disorders can negatively impact remission from an anxiety disorder, although comorbid externalising disorders did not show this same negative effect. By excluding children with comorbid disorders, the generalisability of the studies is compromised, especially considering the evidence that many children with anxiety disorders also suffer from co-morbid disorders such as those excluded from these studies (Hoff Esbjørn et al., 2010; Kendall et al., 2010).

The studies included in this analysis have provided evidence for the efficacy of transdiagnostic CBT across a number of anxiety disorders, including generalised anxiety disorder, separation anxiety disorder, and social phobia. Although children with panic disorder and agoraphobia were also included, there were very few cases of these disorders in any of the trials and so it is not possible to conclude about the efficacy of CBT for these disorders. Moreover, none of the studies included here reported intervention effects for the different disorders, meaning that we do not know whether transdiagnostic CBT is differentially effective for the different anxiety disorders: there is emerging evidence (e.g. Ginsburg et al., 2011) that some anxiety disorders may respond better than others to transdiagnostic CBT. For instance, participants with a social phobia diagnosis at baseline were less likely to remit from their diagnosis after 12 weeks of treatment compared to those without a social phobia diagnosis, whereas this significant difference was not also the case for those with or without generalised anxiety disorder or separation anxiety disorder diagnoses (Ginsburg et al., 2011).

The current meta-analysis includes studies that deliver transdiagnostic CBT using both group and individual CBT formats. The results of the separate analyses for individual and group CBT delivery suggest that transdiagnostic CBT was effective in treating anxiety in children

regardless of the format of the treatment. This suggests that there is no additional benefit in Child and Adolescent Mental Health Services offering individual over group CBT treatments for children with anxiety disorders.

In contrast to Cartwright-Hatton et al.'s (2004) findings that there were no randomised controlled studies for the role of CBT in reducing anxiety symptoms for children under the age of six, this review found two studies that included children from the age of four. However, further research is still required to be able to draw conclusions about the success of transdiagnostic CBT with this younger age group, especially considering that many anxiety disorders have very early onsets. Similarly, further research is required to investigate the success of transdiagnostic CBT with adolescents aged 15-18, which is another area with minimal evidence from randomised controlled trials.

In conclusion, this paper confirms that transdiagnostic CBT appears to be an effective treatment for the remission of anxiety in children and young people. It identifies some remaining gaps in the literature, including the efficacy of transdiagnostic CBT across separate anxiety disorders and the impact of comorbid disorders on anxiety remission. There is also a need for more research evidence for the efficacy of transdiagnostic CBT for young children and older teenagers.

# Chapter 3: Paper 2 - Are sleepy children less reassured by parents faking bravery?

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## 3.1 Abstract

Children can learn and unlearn fearful responses to situations following appropriate vicarious learning experiences. The current paper considers whether child sleepiness and sleep problems interact with children's fear responses following negative and positive vicarious learning experiences with their parents. Parents were invited to insert their hand into a mystery box ('shock box') in three conditions: control, where no shock was expected; 'no disguise' where parents expected a possible shock but were allowed to react freely; and 'disguise fear', where parents expected a possible shock and were instructed to fake bravery. Children watched videos of their parents' interactions with the mystery boxes and were then asked to insert their hands into the same boxes. Heart rates and reaction times were recorded as children approached the boxes. Children's heart rates significantly increased from the control to the two experimental conditions, but did not significantly decrease from the 'no disguise' box to the 'disguise fear' box. Sleep problems, but not sleepiness, was found to interact with this main effect. Children with higher sleep problems scores showed the greatest increase in heart rate from the control to the experimental conditions. It is possible that this finding is reflective of lower heart rates for sleepy children compared to non-sleepy children when at-rest. No main effects or interaction effects with sleep problems or sleepiness were found for children's fear belief ratings or reaction times across the three conditions.

## 3.2 Introduction

Vicariously learning, or modelling others' behaviour, is a cost-effective method for individuals to learn about their environment without making the same errors made by others previously (Bandura, 1971). For children, the most readily available models are often their parents; however, this can be problematic when parents model excessively anxious behaviours (de Rosnay et al., 2006; Muris, Steerneman, Merckelbach, & Meesters, 1996).

Rachman (1977) suggests that there are three pathways through which individuals acquire fears including conditioning, vicarious learning, and the transmission of information.

The conditioning pathway involves a direct pairing of a neutral stimulus with an aversive stimulus, which results in a fear experience. On the other hand, the vicarious learning and the transmission of information pathways involve indirect acquisition of fears through, respectively, observational learning and modelling the behaviour of others, and through receiving negative information or instructions about the stimulus (Rachman, 1977). Rachman (1977) proposed that the everyday fears of non-life threatening stimuli (such as clowns), as opposed to biologically significant fears (such as fears of potentially life threatening stimuli, including snakes or heights), were most likely to be acquired through vicarious learning or the transmission of negative information about the stimuli. Results from a survey of over a thousand children and young people suggested that most of these children acquired their fears from vicarious learning or information pathways (Ollendick & King, 1991). Further evidence for the vicarious learning pathway of fear acquisition has been found from studies of mothers and toddlers in which mothers are instructed to react either negatively or positively towards stimuli (de Rosnay et al., 2006; Dubi et al., 2008; Gerull & Rapee, 2002). Following negative reactions from their mothers, toddlers showed increased fear responses to both fear-relevant stimuli, such as snakes and spiders (Gerull & Rapee, 2002) and to fear-irrelevant stimuli, such as mushrooms and flowers (Dubi et al., 2008), compared to when their mothers gave positive reactions to the stimuli. Similarly, infants were more avoidant of strangers following anxious mother-stranger interactions compared with non-anxious mother-stranger interactions (de Rosnay et al., 2006).

Positive vicarious learning experiences can be protective against the development of children's fears (Egliston & Rapee, 2007), with benefits of positive vicarious learning, in terms of reduced fear beliefs and avoidance, seen even after children were previously given negative information about a stimulus (Kelly et al., 2010). Egliston and Rapee (2007) found that children who received positive vicarious learning experiences from their mothers about a fear-relevant stimulus demonstrated more positive affect and approach behaviours towards the stimulus than those who were simply exposed to the stimulus. In addition, positive vicarious learning from peers towards an animal stimulus not only decreased fear beliefs and avoidance towards that

animal, but also decreased fear beliefs and avoidance for another animal stimulus for which the child did not have a vicarious learning experience (Broeren, Lester, et al., 2011).

Given that sleep problems have been found to affect a variety of cognitive processes, the current study considers the impact that child sleep problems and sleepiness may have on children's vicarious learning experiences. For instance, evidence from the adult literature suggests that sleep deprivation negatively affects participants' cognitive efficiency and attention on reaction time tasks (Acheson, Richards, & de Wit, 2007), and decreases information retrieval in participants presented with novel and previously seen facial stimuli (Mograss, Guillem, Brazzini-Poisson, & Godbout, 2009). In addition, research from the child and adolescent literature has shown that sleep-restricted adolescents have lower attention and diminished learning compared with when they had a healthy sleep duration (Beebe et al., 2010), and reaction times of 9-12 year old children were significantly deteriorated following a 30 minute sleep restriction period (Sadeh et al., 2003). In a review of sleep and memory research in children, Kopasz et al., (2010) concluded that sleep is important for a variety of memory processes in children, including memory encoding, working memory and memory consolidation, and that sleep is particularly important for complex memory tasks. Another review found that sleep duration was positively related to cognitive performance, such as executive functioning, although did not find correlations between sleep duration and attention or memory (Astill et al., 2012). In addition to affecting cognitive processes of learning and memory, sleep problems have been shown to affect emotional cognitive processes, such as emotional information processing (Soffer-Dudek et al., 2011). For instance, sleep problems in adolescents affected their proficiency in information processing when identifying and processing emotions, but the same effect was not found in a neutral condition in which children were required to process gender (rather than emotions) during the information processing task (Soffer-Dudek et al., 2011).

With sleep deprivation and sleep problems found to affect a range of cognitive processes in both adults and children, it is plausible that sleep problems and sleepiness in children may affect the cognitive processes involved in anxiety in general, and vicarious learning-related processes in particular. However, evidence is currently lacking for the role of sleep problems and sleepiness on vicarious learning in childhood anxiety. Given the role that sleep has on other cognitive processes in children, and given the strong comorbidity between sleep problems and anxiety in children (e.g. Alfano, Ginsburg, & Kingery, 2007; Forbes et al., 2008; Hudson, Gradisar, Gamble, Schniering, & Rebelo, 2009), it is possible that sleep problems and/or sleepiness will have an impact on cognitive and behavioural processes involved in childhood anxiety, including the vicarious learning of fears.

The current study considers the effect of child sleep problems and sleepiness on their identification of emotional cues given by parents in a potentially threatening situation. Two sets of parental cues are explored: the first involves parental cues given in the parents' spontaneous response to the threatening situation (negative vicarious learning), and the second explores parental cues in a positive vicarious learning scenario (i.e. when parents were asked to disguise their fear in the threatening situation). It was hypothesised that children with greater sleep problems and sleepiness would show heightened anxiety following the negative vicarious experience, compared to less sleepy children. It was also hypothesised that sleep problems and sleepiness would interfere with the reassurance that the children receive from the positive parental vicarious learning scenario, with children with greater sleep problems and sleepiness less reassured by their parents faking bravery towards the anxiety-provoking stimuli. The current study considers the effect of sleep problems and sleepiness on children's vicarious learning in terms of physiological (heart rate), cognitive (fear beliefs) and behavioural (reaction times) processes.

## 3.3 Method

### 3.3.1 Power

To achieve 80% power to detect a medium effect size of 0.26, assuming an alpha of .05, this study required 91 participants. Ninety-three participants took part in this study and so 81% power was achieved based on these criteria.

### 3.3.2 Participants

Participants included 93 children (33% female), of whom approximately half (53.8%) were children of clinically anxious parents (32.6% female), and approximately half (46.2%) were children of non-anxious parents (38% female). The majority of the sample was White British (87%), with other ethnic groups including White Other (5.4%), Mixed White and Asian (3.2%), Mixed Other (2.2%), Mixed White and Black African (1.1%), and Other (1.1%). The mean age of the children was 6.98 years (SD = 1.31).

All parents included in the study had a child aged 5-9 years, a good standard of English, and neither the parent nor the child had major developmental or intellectual disabilities. Clinical participants (parents) were included if they had any type of anxiety diagnosis and were either referred from the local NHS services or were self-referred. Their diagnosis was verified by the Anxiety Disorder Interview Schedule (ADIS) diagnostic interview. Exclusion criteria for clinical participants included parents who lacked the capacity to consent to participation according to referrers' opinions, and whose needs were inappropriate for a group-based intervention. This included a current active psychosis, severe depression, current manic state or certain Axis II conditions. Non-clinical participants were recruited through adverts placed in local newspapers, parenting magazines, and the trial website, and through contacting a database of parents who had previously taken part in other developmental studies at the University (and had given consent to be contacted for future studies). Exclusion criteria for the non-clinical sample were participants who had an anxiety disorder.

NB: Parents and children included in this study participated in a number of experimental tasks. This paper reports on a task completed by both parents and children, although for the purpose of this paper, the results of this task are reported for children only.

### 3.3.3 Measures

#### *3.3.3.1 Demographics*

Background information was collected about the parent and child, including date of birth, gender, ethnicity, financial situation and parent qualifications.

***3.3.3.2 Anxiety Disorders Interview Schedule (Adult version) (ADIS)*** - Brown, DiNardo, and Barlow (1994)

The ADIS was completed by a trained clinical studies officer in order to confirm the anxiety diagnoses of adult clinical participants. The following sections were used in the current study: panic disorder, agoraphobia, social phobia, generalised anxiety disorder, obsessive compulsive disorder, specific phobia, posttraumatic stress disorder, and hypochondriasis. Sections on major depressive disorder, dysthymic disorder, mania/cyclothymia, somatization disorder, mixed anxiety/depressive disorder, alcohol abuse/dependence, substance abuse/dependence, and non-organic psychosis were excluded from the interview.

***3.3.3.3 Spence Child Anxiety Scale (Parent rating) (SCAS)*** - Spence (1998)

This parent-rated questionnaire gives an overall measure of child anxiety, and includes subscales measuring panic and agoraphobia, separation anxiety, physical injury fears, social phobia, obsessive compulsive disorder, and generalised anxiety disorder. The SCAS has 38 items rated on a 4-point scale with scores of 0-3 given to responses of ‘never’, ‘sometimes’, ‘often’, and ‘always’, respectively. This measure uses a clinical cut off of 31.4 for boys, and 33 for girls. This scale has good- to excellent internal consistency, with Cronbach alphas ranging from .61 to .92 across the subscales, and has good validity indicated by strong correlations ($r$ = .55 - .59) between this scale and the internalising subscale of the Child Behaviour Checklist (Nauta et al., 2004). In addition, the SCAS shows good discriminant validity in terms of identifying children who reach clinical cut-offs for anxiety diagnoses (Nauta et al., 2004).

***3.3.3.4 Children’s Sleep Habits Questionnaire (CSHQ)*** - Owens, Spirito, and McGuinn (2000)

This parent-rated measure of children's sleep habits and sleep difficulties includes sections on bedtime, sleep behaviour, waking during the night, morning waking, and daytime sleepiness. Parents rated the items on a 3-point scale ('usually', 'sometimes', 'rarely') and indicated whether the habit was a problem or not, with high scores indicating that the habit was a problem. As recommended by Owens et al., (2000), a total sleep problems score was calculated using 33 of the 48 items from the questionnaire, and a score of 41 represented the clinical cut-off. The total scale has good internal consistency alphas of .68 based on a community sample and .78 based on a clinical sample, and the scale has good test-retest reliability with correlations ranging from .62 - .79 across the subscales (Owens et al., 2000). The scale was found to be valid in terms of distinguishing between community and clinical samples (Owens et al., 2000).

#### *3.3.3.5 Child Sleepiness Scale*

This scale is based on the Pediatric Daytime Sleepiness Scale (PDSS, Drake et al., 2003). The original PDSS was a child self-report measure of children's general daytime sleepiness, had a split-half reliability of .80 and .81, and was reported to be sensitive to detecting variations in sleepiness (Drake et al., 2003). The scale was adapted as a parent-reported measure of their child's sleepiness both in general and on the day of testing. To measure the child's '*current sleepiness*', additional questions were included. The wording of the questions and responses were modified so that the same responses could be used for questions about '*current sleepiness*' and general or '*usual sleepiness*'. It was not possible to adapt two questions from the original PDSS in this way, and so these were excluded from the questionnaire. The adapted questionnaire had 12 items, each rated on 5-point scales.

#### *3.3.3.6 Fear Belief Measure*

After watching videos of their parents completing each condition of the task (see Section 3.3.4), children were asked to rate the mystery box seen in the video on a five-point pictorial scale of how 'nice' or 'nasty' they thought the contents of the mystery box were, with low scores

indicating ‘nice’ and high scores indicating ‘nasty’ ratings. The pictorial scale included happy, sad and neutral faces.

#### *3.3.3.7 Heart Rate*

Children’s heart rate was measured using a Finger Pulse Oximeter & Heart Rate Monitor. The heart rate monitor was placed on the children’s finger at the beginning of their participation in the task, and was removed once the children had completed all conditions. Heart rate was recorded as children’s hand first approached each mystery box.

### 3.3.4 Procedure

Ethical approval was received from the author’s university and the National Health Service (NHS) Research Ethics Service. The study was explained to the parent and the child, and each gave their consent to take part. Parents and children completed the sleep and anxiety questionnaires prior to completing the ‘mystery box’ task.

The mystery box task was conducted separately with the parent and the child. During the task, the parent was informed: “This mystery box is capable of giving harmless electric shocks. It gives them at random intervals so you may or may not get a shock if you put your hand in this box. The shocks are harmless and not painful – it just feels a bit like getting a splinter” [*the box actually never gave shocks*]. Parents were then informed that they would be asked to put their hand inside the box three times. On the first occasion, the parents were shown that the box was unplugged so it could not give them an electric shock and they were asked to put their hand in this unplugged box (the control condition). On the second occasion, the box was plugged in to an electricity socket and parents thought it could give them a mild electric shock, and they were asked to put their hand into it (the ‘no disguise’ condition). On the third occasion, the box remained plugged in, so parents still thought it could give a mild electric shock. However, on this occasion, parents were informed that the videos of them completing this task were going to be shown to their child, and that for this final box, they were to disguise their fear about putting their hand into the box (the ‘disguise fear’ condition). Prior to each of

these three conditions, parents were asked to rate how anxious they felt about putting their hand in the box, and the entire task was video-taped. After completion of the parent task, the parent was debriefed and informed that the box did not actually give shocks, and were informed that their child would not be told that the box may give them a shock.

The video of the task was edited to just show the parent putting their hand into the box for each of the three conditions. The child was then invited into the lab to complete their part of the task, and were asked to clip a heart-rate measure on the index finger of their non-dominant hand. The children were played each of the three video clips in a random order, with the sound switched off. After watching each clip, children were asked to rate fear beliefs on a pictorial scale of how 'nice' or 'nasty' they thought the item inside the box was. They were then shown the mystery boxes and were invited to put their hand in the box that they had apparently just seen their parent interacting with. This was repeated for the three boxes, all of which were identical. The children's reaction times to place their hand into each of the mystery boxes was coded by two independent coders, with an intra-class correlation of .903 for Box 1, of .798 for Box 2, and of .835 for Box 3, indicating excellent consistency across the two raters (according to values suggested by Fleiss, 1999).

### 3.3.5 Data analysis

As all children engaged in each of the three conditions of this study, and as a number of dependent variables were assessed (fear beliefs, heart rate and reaction time), a repeated measures multivariate regression analysis was conducted. Mauchley's test of sphericity indicated that the assumption of sphericity was met for the fear belief ($\chi^2(2)= 2.04$, $p$ = ns) and heart rate ($\chi^2(2)= 2.20$, $p$ = ns) dependent variables, but was violated for the reaction time dependent variable ($\chi^2(2)= 8.00$, $p$ = < .05). Therefore, degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity for reaction time ($\varepsilon = .85$). Results for the main effect of condition were explored prior to an exploration of any interaction effects of children's sleepiness/sleep problems on this main effect. Helmert planned contrasts were conducted to

consider the statistical differences in scores across the three conditions. The first contrast explored whether there was a significant difference in the mean of the control condition and the combined mean of the two experimental conditions (the 'no disguise' and 'disguise fear' conditions). The second contrast explored whether there was a significant difference in the mean of the 'no disguise' condition and the 'disguise fear' condition. To explore the interaction of sleep problems on the main effect of condition on children's responses to the mystery boxes, estimated marginal means were calculated, based on the mean sleep problems score. Sleep problem scores that fell 1 standard deviation above and below the mean represented high and low sleep problem scores, respectively.

## 3.4 Results

### 3.4.1 Main effects of condition

A repeated-measures multivariate regression was conducted to consider the effect of sleep problems and sleepiness on children's responses to the three mystery boxes ('control' condition, 'no disguise' condition, and 'disguise fear' condition) in terms of their reaction times to place their hand in the box, their fear beliefs about the box, and their heart rate as they were about to place their hand in the box (see Table 3.1 for means and standard deviations).

Table 3.1: Means and standard deviations for the dependent variables of the multivariate regression

| Condition | Reaction Time<br>Mean (SD) | Fear Beliefs<br>Mean (SD) | Heart Rate<br>Mean (SD) |
|---|---|---|---|
| Control | 1.56 (.91) | 2.78 (1.18) | 89.87 (27.25) |
| No Disguise | 1.97 (2.02) | 2.69 (1.40) | 93.69 (28.00) |
| Disguise Fear | 1.90 (1.79) | 3.00 (1.31) | 91.89 (26.08) |

According to the multivariate tests, there was a significant main effect of condition (Pillai's Trace = 2.97, $p < .01$), suggesting that condition had a significant effect on children's reaction times, fear beliefs and/or heart rate. The univariate tests indicated that there was a main effect of condition on the child's heart rate as they placed their hand into each box, $F(2, 82) = 6.71$, $p < .01$. Figure 3.1 suggests that children's heart rate increased from the control condition to the 'no disguise' condition, and decreased from the 'no disguise' condition to the 'disguise fear' condition, suggesting that children, irrespective of sleep problems or sleepiness, showed increased fear when their parents were in an anxiety-provoking situation, but that they were somewhat reassured by their parents disguising their fear. Helmert planned contrasts revealed that children's heart rate for the control condition was significantly lower than for the mean effect of the experimental conditions ('no disguise' and 'disguise fear' conditions, $F(1, 41) = 13.34$, $p < .001$, $r = .50$), but that there was no significant difference between heart rates for the 'no disguise' condition and the 'disguise fear' condition, $F(1, 41) = 1.84$, $p = .18$, $r = .21$. These findings suggest that children's heart rates in the two experimental conditions were greater than in the control condition, but that the experimental conditions were not significantly different from each other. There were no main effects of condition on children's fear beliefs ($F(2,82) = 1.87$, $p = .16$) or reaction times ($F(2,82) = 1.37$, $p = .26$).

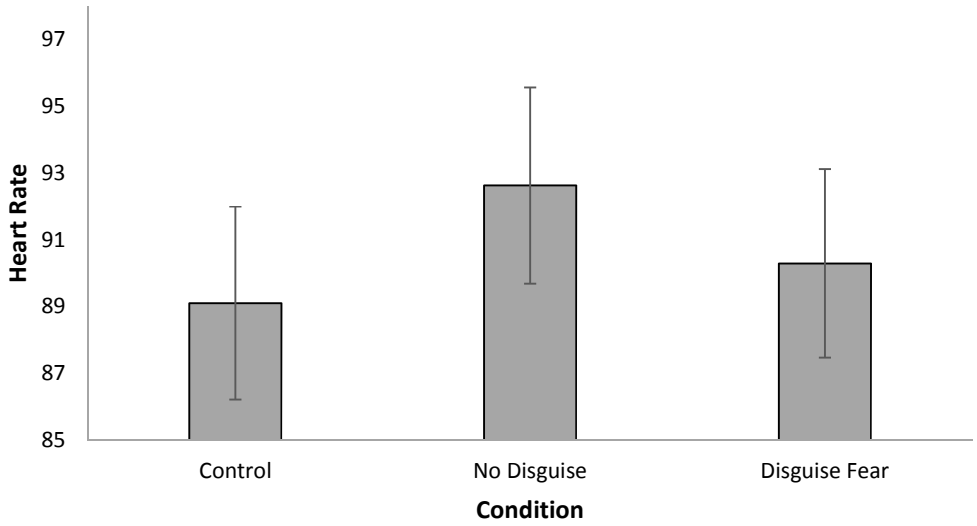

*Figure 3.1: Mean heart rate for children as they were about to place their hands in each of the three mystery boxes (+/- 1 SEM)*

### 3.4.2 Effects of sleep problems / sleepiness

There was a significant interaction effect between condition and parent-rated child sleep problems score on children's fear responses to the mystery box task (Pillai's Trace = 2.39, $p < .05$), suggesting that child sleep problem scores interacted with the main effect of condition on children's fear responses. There were no significant interaction effects between condition and parent-rated current sleepiness or usual sleepiness on children's fear responses towards the mystery box task, $p > .05$. The univariate tests suggested that there was a significant interaction effect between condition and the child's sleep problems score on children's heart rate ($F(2, 82) = 5.95$, $p < .01$), which suggests that children's heart rate across the conditions was affected by their sleep problems score. Helmert planned contrasts between each of the conditions revealed a significant interaction between sleep problems and condition when contrasting heart rate data for children in the control condition with mean heart rate across the two experimental conditions ('no disguise' and 'disguise fear'), $F(1, 41) = 10.49$, $p < .01$, $r = .45$. There was no significant interaction between sleep problems and condition when contrasting heart rate data for children in the 'no disguise' and 'disguise fear' conditions, $F(1, 41) = 2.62$, $p = .11$, $r = .25$. These findings suggest that children's sleep problem scores interacted with the significant difference in mean heart rate for both of the experimental conditions compared to the control condition, and that there was no significant interaction of sleep problems for the difference in mean heart rates for each of the experimental conditions. Figure 3.2 illustrates the interaction between sleep problems score and heart rate across the conditions, using estimated marginal means for heart rate across the conditions. The line representing 'mean sleep problems' shows the estimated marginal means of heart rate for children with sleep problem scores that are at the mean. The line representing 'high sleep problems' shows the estimated marginal means of heart rate, based on sleep problem scores that fell 1 standard deviation above the mean sleep problems score, and the line representing 'low sleep problems' shows the estimated marginal means of heart rate

based on sleep problem scores that fell 1 standard deviation below the mean. Figure 3.2 suggests that children with low, medium and high sleep problems had different estimated mean heart rates for the control condition, with children with high sleep problems scores showing the lowest estimated mean heart rate, and children with low sleep problems scores showing the highest estimated mean heart rate. However, during the experimental conditions, children with low, mean or high sleep problem scores appeared to react in a similar way, with similar heart rates evident for low, mean and high sleep problem children for both the 'no disguise' and 'disguise fear' conditions. The greatest change in heart rate between the control and experimental conditions can, therefore, be seen for children with high sleep problems scores, with heart rate estimated to increase the most for this group from the 'control' to 'no disguise' and 'disguise' conditions, compared with children with mean or low sleep problem scores.

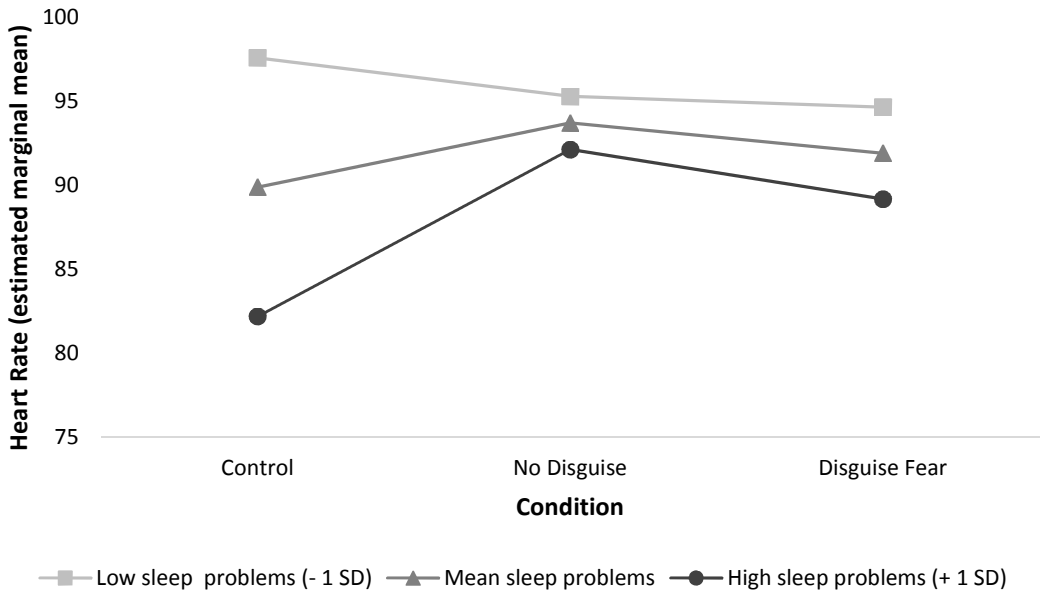


*Figure 3.2: Mean heart rate for children with mean sleep problem scores, and with sleep problem scores 1 standard deviation above (high sleep problems) and below the mean (low sleep problems)*

There were no interaction effects between sleep problems scores and reaction times for children placing their hand inside the three mystery boxes ($F(2,82) = 0.19$, $p = .83$), or for fear belief ratings of each of the boxes ($F(2,82) = 2.45$, $p = .09$).

## 3.5 Discussion and conclusions

The current study considers the effects of sleep problems and sleepiness on children's negative vicarious learning experiences, in which parents showed a fear reaction towards a mystery box stimulus, and positive vicarious learning experiences, in which parents tried to disguise their fear towards the mystery box stimulus. Three separate outcome measures were considered, including the child's heart rate when they were about to place their hand into the mystery box, the child's fear beliefs prior to approaching the box, and the child's reaction time to place their hand into the mystery box. The results of the multivariate regression analysis showed that, irrespective of sleep problems scores or sleepiness scores, children had significantly different heart rates when approaching each of the boxes, with the lowest heart rate found for the control condition and the highest heart rate found for the 'no disguise' condition. Although a reduction was seen in mean heart rate from the 'no disguise' condition to the 'disguise fear' condition (the positive vicarious experience), this reduction did not reach significance. However, these findings suggest that the experimental manipulation used in this study was effective, as children showed increased physiological fear towards the 'no disguise' condition compared with the control condition, and with children showing some reassurance when their parents faked bravery for the 'disguise fear' condition, although this latter effect did not reach statistical significance.

The aim of the current study was to consider the effect of sleep problems and sleepiness on both negative and positive vicarious learning experiences. Although the current study did not find an effect of current or usual *sleepiness* on the vicarious learning experiences, sleep *problems* were found to significantly interact with children's heart rate across the control and experimental conditions. Results from the current study suggest that children with higher sleep

problems scores had lower heart rates across each of the conditions compared with children with lower sleep problems scores, with this particularly the case for the control condition. This may be due to sleepiness being associated with lower heart rates, as has been found in a sample of adults (Carrington et al., 2005). However, compared with those with average or low sleep problem scores, children with high sleep problem scores showed the greatest increase in heart rate from the control to the experimental conditions, whereas a much smaller increase was found for children with average sleep problems scores, and a slight decrease was found for children with low sleep problems scores. This finding offers support for the associations found in previous research between sleep problems and anxiety (Alfano et al., 2007; Forbes et al., 2008; Hudson et al., 2009) as one would expect children's sleep problems to negatively interact with their physiological response in anxiety provoking situations. No interaction was found between sleep problems and heart rate for the 'no disguise' and 'disguise fear' conditions, suggesting that sleep problems score did not interact differentially across the positive and negative vicarious learning experiences. However, this non-significant result is likely to be accounted for by the non-significant reduction in heart rate across these conditions irrespective of sleep problems scores, which suggests that the positive vicarious learning experience was not wholly successful in reducing children's physiological fear response to the situation, although a small reduction can be seen when considering the means.

Other measures of children's fear included fear belief ratings and reaction times for the child to place their hand into each of the three mystery boxes. However, no main effects were found for these measures across the conditions, nor did sleep problems scores interact with fear belief ratings or reaction times across the conditions. These results were counter to the hypotheses of this study, as it was expected that children would have the lowest fear belief ratings and reaction times for the control condition, highest fear belief ratings and reaction times for the 'no disguise' condition, and reduced fear belief ratings and reaction times for the 'disguise fear' condition (as was seen for the heart rate data). Although this pattern is evidenced for the mean reaction times, this effect did not reach statistical significance, which may be due

to a lack of variability of reaction times across the sample, as the vast majority of children responded very quickly to each of the conditions. Similarly, children's mean fear belief ratings did not follow the anticipated pattern of scores across the conditions, which may suggest that the pictorial fear belief scale did not adequately capture the children's fear beliefs. In addition to hypothesising that this main effect would be found, the current study hypothesised that sleep problems would interact with condition for each of the three outcome measures. However, no significant effect was found for reaction time or fear beliefs, although, it is possible that this was due to the non-significant main effect of condition found for the fear beliefs and reaction times measures.

The current study may have been limited by the use of video observations rather than by using direct observation, where children directly observe their parents while they engaged in the three conditions. However, this technique was necessary for the current study so that the three conditions of the mystery box task could be explained without the children present and so that parents' voices (a potential source of verbal fear information) could be removed. Given the significant results for the heart rate outcomes in the current study, the use of videos has arguably not been an issue. However, it is possible that a significant main effect of cognitive processes (fear beliefs rating) and behavioural processes (reaction times), and an interaction effect between sleep problems and these processes may be achieved using direct observation. Further research could consider the impact of sleep problems on both negative and positive vicarious learning experiences in which the child directly observes their parents' reactions towards anxiety provoking stimuli.

Further research is also required to explore the role of child *sleepiness* in vicarious learning processes (as opposed to sleep *problems*). Although the current study did not find sleepiness to interact with the cognitive, physiological or behavioural processes of the task, this could be explained by limitations in the sample used in the current study. For instance, parent reports of child sleepiness suggested that the sample used for this study did not have a large

range of sleepiness scores, with most children (89%) receiving scores on the lower end of the scale. Further research using a sample of children with a more diverse range of sleepiness scores may be necessary to identify whether child sleepiness affects the child's responses towards anxiety-related vicarious learning experiences.

In conclusion, the current study provides some interesting data on the impact of child sleep problems on vicarious learning experiences, with increased sleep problems found to predict a lower heart rate across the conditions compared with children with lower sleep problems scores. In addition, increased sleep problems appear to increase the physiological response (heart rate) of children in the experimental conditions compared to the control condition, when compared with those with lower sleep problems scores. This suggests that children with greater sleep problems may be more affected by the vicarious experiences of their parents' engaging in an anxiety-provoking task. Although it did not reach significance, there was some reduction in physiological fear response from the 'no disguise' to 'disguise fear' conditions. Unlike sleep *problems*, sleepiness was not found to interact with the cognitive, physiological, or behavioural processes of vicarious learning, although this may be explained by the low levels of sleepiness reported across the sample. Further research employing a sample with more diverse levels of sleepiness would be beneficial, to explore whether sleepiness interacts similarly with anxiety-related vicarious learning experiences.

# Chapter 4: Paper 3 - The effect of sleepiness and sleep problems on ambiguity resolution in children

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## 4.1 Abstract

**Background**: Anxious children show threat interpretation biases and negative emotions towards ambiguous situations, with a number of factors (such as parenting, positive or negative feedback, and bodily sensations) found to influence these interpretations. However, it is not currently known whether child sleepiness or sleep problems may influence children's interpretations of ambiguity, and the current paper addresses this. **Method**: Children and parents completed questionnaires about the children's symptoms of anxiety, sleepiness, and sleep problems. Children then completed a computerized version of the Ambiguous Situations Questionnaire, during which they gave freely spoken responses and forced choice responses to the ambiguous scenarios. Their verbal responses were coded according to whether they gave threat or non-threat interpretations for the situations. The forced choice options included one threat- and one non-threat interpretation of the situation. **Results**: Significant correlations were found between child anxiety and *sleep problems*, but not between child anxiety and *sleepiness.* A mediation analysis was conducted to consider whether children's threat interpretation bias mediated the relationship between anxiety and sleep problems in children. No mediation effect was found. **Conclusions**: The non-significant findings in this paper may be due to sampling and/or methodological limitations. Further research, that addresses these issues, is required.

## 4.2 Introduction

There is considerable evidence for the association between sleep problems and anxiety (e.g. Alfano et al., 2006; Alfano, Zakem, Costa, Taylor, & Weems, 2009; Chase & Pincus, 2011; Gregory & Eley, 2005; Johnson, Chilcoat, & Breslau, 2000; Ong et al., 2006). For instance, 83% to 90% of anxious children also have one or more sleep complaint, including nightmares, trouble sleeping, or feeling over-tired (Alfano et al., 2006; Chase & Pincus, 2011), and the odds of children with problems sleeping also suffering from anxiety were 4.7% - 9.7% higher than for those children without sleep problems (Johnson et al., 2000). In addition, anxious children go to bed significantly later and have significantly less sleep than non-anxious children (Hudson

et al., 2009) and poor sleep quality in adults has been shown to be positively correlated with reported fear and anxiety during voluntary hyperventilation (Babson, Feldner, Connolly, Trainor, & Leen-Feldner, 2010). The relationship between sleep problems and anxiety appears to be bidirectional, with evidence to suggest that daytime stress was associated with less sleep in the evening, and in turn, less sleep at night was related to higher anxiety the following day (Fuligni & Hardway, 2006). Similarly, anxiety has been found to be associated with a range of sleep problems, while sleep problems have been found to be associated with a range of anxiety disorders (Gregory & Eley, 2005).

However, the relationship between sleep problems and the *processes* involved in childhood anxiety has received little attention. Given the strong associations found between sleep and anxiety, it is plausible that sleep problems may play a role in the processes known to be involved in childhood anxiety disorders. There is evidence that sleep problems are associated with cognitive processes such as attributional style (Gregory & Eley, 2005), cognitive errors, and control beliefs (Alfano et al., 2009). However, there does not appear to be any research examining the association between sleepiness and other cognitive processes involved in childhood anxiety, such as interpretation bias, attentional bias, and emotion recognition, or for the role of sleepiness in anxiety processes.

Negative interpretation bias is associated with increased anxiety in both adults and children (Clark & Wells, 1995; Muris, Kindt, et al., 2000; Taghavi, Moradi, Neshat-Doost, Yule, & Dalgleish, 2000; Wilson, MacLeod, Mathews, & Rutherford, 2006). Ambiguous stimuli are often employed to measure threat interpretation biases in children with anxiety, such as in ambiguous situations or scenarios (e.g. Bögels & Zigterman, 2000; Muris et al., 2000; Waters, Craske, Bergman, & Treanor, 2008), or homophone words (Taghavi et al., 2000). Findings from these studies suggest that anxious children show more threat interpretation biases towards, and more negative emotions about, the ambiguous stimuli compared with non-anxious children. For instance, when asked to incorporate ambiguous homograph words (for example,

die/dye) into a written sentence, anxious children were more likely to interpret the words as threat words than non-anxious children (Taghavi et al., 2000). Similarly, when presented with an ambiguous situation or scenario, anxious children were more likely to place a threat interpretation on the situation compared with non-anxious children (Bögels & Zigterman, 2000), particularly when the situation was more personally salient to the child (Micco & Ehrenreich, 2008). Within ambiguous situation tasks, anxiety was correlated with a higher frequency of reports of threat and ratings of how threatening a story was, more threat interpretations, and greater negative feelings and cognitions (Muris, Kindt, et al., 2000). Findings from longitudinal research suggest that the association between threat interpretation biases and childhood anxiety increased across time, and was bidirectional, in that threat interpretation bias was predicted by anxiety symptoms, while anticipated distress for the ambiguous situations predicted change in anxiety (Creswell & O'Connor, 2011).

Various factors have been shown to influence children's tendency towards threat interpretation biases, including external and internal influences, such as: parenting (Creswell et al., 2005), positive or negative feedback (Lester, Field, & Muris, 2011a; 2011b), or bodily sensations (Muris, Mayer, & Bervoets, 2010). For instance, significant correlations were found between mother and child threat interpretation biases (Creswell et al., 2005), and children's interpretation biases partially mediated the relationship between an over-controlling parenting style and child anxiety (Affrunti & Ginsburg, 2012). Similarly, children's threat biases were found to be modifiable using a learning task in which children were either given positive or negative feedback for their interpretation of ambiguous situations (Lester et al., 2011a, 2011b). Bodily sensations have, likewise, been found to influence children's threat interpretation bias, as suggested by findings that when presented with an alleged sound of their own heartbeat, children interpreted ambiguous situations as more threatening compared to children in a control group who were listening to a drum beat during the task, which used the same number of beats per minute as the 'heartbeat' (Muris, Mayer, et al., 2010). These findings led the authors to

conclude that internal physical sensations may influence the interpretation of ambiguity due to the child relying on their bodily sensations when evaluating events (Muris, Mayer, et al., 2010).

It is therefore possible that other factors, such as sleep problems or sleepiness, may also influence children's threat interpretation of ambiguity, particularly given the strong associations between sleep problems and anxiety (for example, Alfano et al., 2006). There is some evidence for this in adult samples, with sleepiness found to be associated with a bias towards threat interpretations of ambiguous sentences in adults with chronic insomnia (Ree & Harvey, 2006), and in an adult sample of poor sleepers (Ree, Pollitt, & Harvey, 2006). However, there does not appear to be any research that considers whether sleep problems or sleepiness are associated with a threat interpretation bias in children, yet this could have implications for optimising the treatment of anxious children's cognitive biases. The current study aims to address this gap in the literature by exploring the role of sleep problems and sleepiness on children's threat interpretation biases when presented with ambiguity. Children of parents with anxiety disorder diagnoses were included within the sample, as well as a control sample of children. This 'at-risk' sample was included in the current study based on findings that children of anxious parents show more symptoms of anxiety and have an increased risk of also developing an anxiety disorder compared to children in control groups (Merikangas, Avenevoli, Dierker, & Grillon, 1999; Turner et al., 1987). It was hypothesized that child sleep problems and sleepiness would be significantly associated with child anxiety, and that children's threat interpretation biases would partially mediate this relationship.

## 4.3 Method

### 4.3.1 Power

To achieve 80% power to detect a medium effect size ($f^2$) of 0.15, assuming an alpha of .05, this study required 68 participants. Therefore, 89% power was achieved based on the 85 participants recruited for this study. Owing to instrument failure, data was available for only 53 children for

the verbal responses on the ambiguous situations questionnaire, which meant that 69% power was achieved for these analyses.

### 4.3.2 Participants

Participants included 85 children (38% female) aged 5 to 9 years (mean = 7.6 years, SD = 1.30) and their parents, recruited as part of a larger study. Most children were of White-British ethnicity (85%). Other ethnic groups included White-Other (5%), Mixed White and Black African (1%), Mixed White and Asian (3.5%), and Mixed-Other (3.5%). The remaining 2% were undisclosed. Of these participants, 41 (39% female) were children of clinically anxious parents, and 44 (36% female) were children of non-clinically anxious parents.

Inclusion criteria were that the parent had a child aged 5-9 years and a good standard of English, and neither parent nor the child had major developmental or intellectual disabilities. Clinical participants (parents) were included if they had any type of anxiety diagnosis and were either referred from the local NHS services or were self-referred. Their diagnosis was verified by the Anxiety Disorder Interview Schedule (ADIS) diagnostic interview. Exclusion criteria for clinical participants included parents who lacked the capacity to consent to participation according to referrers' opinions, and whose needs were inappropriate for a group-based intervention. This included a current active psychosis, severe depression, current manic state or certain severe Axis II conditions. Non-clinical participants were recruited through adverts placed in local newspapers, parenting magazines, and the trial website, and through contacting a database of parents who had previously taken part in other developmental studies at the University (and had given consent to be contacted for future studies). Exclusion criteria for the non-clinical sample were participants who had an anxiety disorder.

Please note, parents and children included in this study participated in a number of experimental tasks. This paper reports on the results of one of these tasks, which was completed by children only. Questionnaires reported in this paper were completed by both parents and children as specified.

### 4.3.3 Measures

#### 4.3.3.1 Demographics

Background information was collected about the parent and child, including date of birth, gender, ethnicity, financial situation and parents' highest academic qualification.

**4.3.3.2 Anxiety Disorders Interview Schedule (adult version) (ADIS)** – Brown et al. (1994)

The ADIS was completed by a trained clinical research officer, with adult clinical participants only, in order to confirm their anxiety diagnosis. The following sections were used in the current study: panic disorder, agoraphobia, social phobia, generalized anxiety disorder, obsessive compulsive disorder, specific phobia, posttraumatic stress disorder, and hypochondriasis. Sections on major depressive disorder, dysthymic disorder, mania/cyclothymia, somatization disorder, mixed anxiety/depressive disorder, alcohol abuse/dependence, substance abuse/dependence, and non-organic psychosis were excluded from the interview.

**4.3.3.3 Revised Children's Anxiety and Depression Scale (child version) (RCADS)** – Chorpita, Yim, Moffitt, Umemoto, and Francis (2000)

A child self-rated questionnaire to measure separation anxiety disorder, social phobia, generalized anxiety disorder, panic disorder, obsessive compulsive disorder and major depressive disorder. The RCADS has 47 items rated across a 4-point scale with scores of 0-3 given to responses of 'never', 'sometimes', 'often', and 'always', respectively. Good internal consistency (alphas ranging from .73 to .82), and test-retest reliability (alphas ranging from .65 to .80) has been reported for this measure (Chorpita et al., 2000).

**4.3.3.4 Spence Child Anxiety Scale (parent rating) (SCAS)** – Spence (1998)

A parent-rated questionnaire for an overall measure of child anxiety, including measures of panic and agoraphobia, separation anxiety, physical injury fears, social phobia, obsessive compulsive disorder, and generalised anxiety disorder. The SCAS has 38 items rated on a 4-

point scale with scores of 0-3 given to responses of ‘never’, ‘sometimes’, ‘often’, and ‘always’, respectively. This measure uses a clinical cut off of 31.4 for boys, and 33 for girls. This scale has good- to excellent internal consistency, with Cronbach alphas ranging from .61 to .92 across the subscales, and has good validity, indicated by strong correlations ($r$ = .55 - .59) between this scale and the internalising subscale of the Child Behaviour Checklist (Nauta et al., 2004). In addition, the SCAS shows good discriminant validity in terms of identifying children who reach clinical cut-offs for anxiety diagnoses (Nauta et al., 2004).

**4.3.3.5 Children’s Sleep Habits Questionnaire (CSHQ)** – Owens et al. (2000)

A parent-rated measure of children’s sleep habits and sleep difficulties. This measure includes sections on ‘bedtime’, ‘sleep behaviour’, ‘waking during the night’, ‘morning waking’, and ‘daytime sleepiness’. Parents rated the items on a 3-point scale (‘usually’, ‘sometimes’, ‘rarely’) and indicated whether the habit was a problem or not, with high scores indicating that the habit was a problem. Total sleep problems score was based on 33 of the 48 scale items, as suggested by Owens et al. (2000), with a maximum score of 99, and a recommended clinical cut-off of 41. The total scale has acceptable internal consistency alphas of .68 based on a community sample and .78 based on a clinical sample, and the scale has acceptable test-retest reliability with correlations ranging from .62 - .79 across the subscales (Owens et al., 2000). The scale was found to be valid in terms of distinguishing between community and clinical samples (Owens et al., 2000).

**4.3.3.6 Child Sleepiness Scale**

This scale is based on the Pediatric Daytime Sleepiness Scale (PDSS, Drake et al., 2003). The original PDSS was a child self-report measure of children’s general daytime sleepiness, had a split-half reliability of .80 and .81, and was reported to be sensitive to detecting variations in sleepiness (Drake et al., 2003). The scale was adapted in order to be used as a parent-reported measure of their child’s sleepiness, with permission from the authors. To measure whether the child was sleepy on the day of testing, as well as in general, additional questions were included.

The wording of the questions and responses were also modified so that the same responses could be used for questions about current sleepiness and general sleepiness. It was not possible to adapt two questions from the original PDSS in this way, and so these were excluded from the questionnaire. The adapted parent-rated questionnaire had 12 items rated on 5-point scales.

**4.3.3.7 Children's Pictorial Sleepiness Questionnaire** – Maldonado, Bentley, and Mitchell (2004)

Children completed this self-rated measure of sleepiness by selecting one of five pictures of faces to indicate how sleepy they felt.

**4.3.3.8 The Ambiguous Situations Questionnaire (ASQ)** – Barrett, Rapee, Dadds, and Ryan (1996)

This questionnaire consisted of 12 ambiguous sentences that could be interpreted in either a threatening or non-threatening way (six social threat sentences and six physical threat sentences). For each sentence, children responded with both freely spoken interpretations, and with a forced choice between two possible interpretations of the sentence. Free verbal responses were coded by the first author and second-rated by ZH. Substantial inter-rater agreement was found for the coding of the child verbal responses, with Kappa scores ranging from .621 to 1.00 across the questions. One question ("You are walking to school and start to feel sick in your tummy. What do you think has made you feel sick?") initially achieved poor inter-rater agreement (Kappa = -.17). The main issue of disagreement between coders for this question was whether or not "eating too much" was an implied threat due to the expectation that one may be sick because they have eaten too much. After discussion, a decision was made that this was a non-threat response. After re-coding this question, an acceptable Kappa score of .645 was achieved. The scores from the first rater were used for analysis.

**4.3.4 Procedure**

Ethical approval was received from the university and the NHS Research Ethics Service. The study was explained to the parent and the child, and each gave their consent to take part. Parents and children completed the sleep and anxiety questionnaires prior to the child completing the ASQ.

Child participants completed the ASQ by interpreting whether a series of 12 ambiguous situations were threatening or not (e.g. “you are on your way to your friend’s house when a big dog comes up to you”). The questions were displayed in E-Prime (version 2.0) on a Dell laptop. The research assistant read the sentence to the child, and asked them what they thought would happen. Children spoke their responses aloud, and their responses were recorded using a microphone attached to a computer. After giving their verbal response, the children were then read two options of how the situation could be interpreted (one neutral/positive, and one negative), and they selected the option which they thought was most likely, which was recorded using a response box attached to the computer. The spoken and forced-choice responses were coded as threat or non-threat responses, with non-threat responses including both positive and neutral outcomes suggested by the child. A ‘total threat’ score was calculated based on the total number of threats identified across all of the questions, irrespective of threat type.

## 4.4 Results

### 4.4.1 Social and physical threat

The mean number of ambiguous situations that were identified as threatening by the children (according to forced choice responses) was 4.76 (SD = 2.44), with a mean of 2.32 (SD = 1.48) social situations identified as threatening, and a mean of 2.44 (SD = 1.42) physical situations identified as threatening. According to children’s free verbal responses, a mean of 5.15 (SD = 1.99) of the situations were identified as threatening, with a mean of 3.22 (SD = 1.31) social situations identified as threatening, and a mean of 1.96 (SD = 1.30) physical situations identified as threatening.

Since there is no theoretical reason to assume that sleep problems and sleepiness would affect social and physical threat interpretations differently, the scores of the two subscales were summed to create a 'total threat' score. A correlational analysis was conducted to check that there was a significant correlation between these subscales. This analysis confirmed that the social and physical threat scores from the forced choice questions were significantly correlated, $r = .43$, $p < .001$, suggesting that combining these into a 'total threat' score for the main analyses was appropriate. However, the free verbal responses for social and physical threat scores were not significantly correlated ($r = .092$, $p = .52$), although a decision was made to also combine these responses for consistency with the forced choice questions.

### 4.4.2 Sleep and anxiety

Mean scores for the sleepiness, sleep problems and anxiety measures are shown in Table 4.1. Correlational analyses were conducted to consider the relationship between the sleep variables and anxiety. Sleep problem scores were found to have a small positive relationship with parent ratings of child anxiety, $r = .30$, $p < .05$. Parent and child ratings of current sleepiness were not found to be significantly correlated with parent-rated anxiety scores ($r = .16$, $p = .20$ and $r = .04$, $p = .76$ respectively), and parent ratings of usual sleepiness were not significantly correlated with parent-rated anxiety scores ($r = .19$, $p = .12$). Child ratings of anxiety were also considered. Child ratings of anxiety were significantly correlated with parent ratings of child anxiety, $r = .40$, $p < .001$. However, no significant correlations were found between child-rated anxiety scores and parent-rated sleep problem scores ($r = .07$, $p = .59$), nor between child-rated anxiety scores and parent- and child-ratings of current sleepiness ($r = .09$, $p = .45$; $r = .06$, $p = .59$ respectively) or parent-rated usual sleepiness ($r = .13$, $p = .26$). For this reason, subsequent analyses were restricted to exploring the relationship between parent-rated child anxiety and child sleep problem scores.

Table 4.1: Descriptive statistics for the anxiety, sleep problems and sleepiness measures

| Measure | Mean (SD) | Range | Clinical cut-off |
|---|---|---|---|

| | | | |
|---|---|---|---|
| SCAS (parent-rating) | 20.32 (10.59) | 5 - 52 | 31.4 (boys)<br>33 (girls) |
| RCADS (child-rating) | 29.06 (16.24) | 0 - 85 | n/a for total score |
| Sleep problems (parent-rating) | 44.33 (9.10) | 32 - 84 | 41 |
| Usual sleepiness (parent-rating) | 10.79 (4.79) | 6 - 24 | n/a |
| Current sleepiness (parent-rating) | 10.31 (4.47) | 6 - 24 | n/a |
| Current Sleepiness (child-rating) | 2.20 (1.21) | 1-5 | n/a |

*Key*: SCAS – Spence Child Anxiety Scale; RCADS – Revised Children's Anxiety and Depression Scale

The Four Step Approach (Baron & Kenny, 1986) was used to consider whether child threat interpretation bias (as measured by the forced response scores) mediated the significant relationship between parent ratings of child sleep problems and anxiety. Simple regression analyses were conducted for each step. For Step 1, Sleep Problem scores were entered as the independent variable, and Parent-Rating of Anxiety scores were entered as the dependent variable. For Step 2, Sleep problem scores were entered as the independent variable, and Threat Bias entered as the dependent variable, and for Step 3, Threat Bias scores were entered as the independent variable and Parent-Rating of Anxiety scores were entered as the dependent variable. The results of these analyses are shown in Table 4.2, and suggest that threat interpretation bias (according to forced response scores) did not mediate the relationship between sleep problems and anxiety (based on parent reports of both sleep problems and anxiety symptoms), with no significant results found for Steps 2 and 3 (see Table 4.2). Step 4 was therefore not computed, as recommended by Baron and Kenny (1986).

Table 4.2: Mediation analysis results using the Baron and Kenny (1986) Four Step Approach with the forced choice scores on the ASQ

| | *R* | $R^2$ | Beta |
|---|---|---|---|
| Step 1 | | | |
| Sleep problems → Parent-rated anxiety | .302 | .091 | .302* |

| | | | |
|---|---|---|---|
| Step 2 | | | |
| Sleep problems → Threat bias (forced choice) | .165 | .027 | .165 |
| Step 3 | | | |
| Threat bias (forced choice) → Parent-rated anxiety | .040 | .002 | .040 |

*Note*: * $p < .05$

This approach was repeated using children's threat interpretation bias scores according to their free verbal responses to the ambiguous situations. Owing to instrument failure, verbal response data was available for 53 of the 85 children. As in the analysis using forced choice scores, simple regression analyses were conducted for each step. With the exception of using free verbal response scores rather than forced choice scores, the steps for this analysis were the same as the analysis described above. The results of these analyses are shown in Table 4.3, and suggest that threat interpretation bias according to free verbal response scores does not mediate the relationship between parent ratings of sleep problems and anxiety. Step 4 was therefore not computed. Due to the difficulties with coding one of the verbal response questions (feeling sick in the tummy), the analysis was re-run excluding this question. The results of this analysis still indicated that the child's threat interpretation bias did not mediate the relationship between parent-rated sleep problem scores and anxiety after removing this question from the analysis (Step 2: $r = .03$, $r^2 = .00$, Beta = -.03, $p = .86$; Step 3: $r = .18$, $r^2 = .03$, Beta = -.18, $p = .22$).

Table 4.3: Mediation analysis results using the Baron and Kenny (1986) Four Step Approach with the free verbal response scores on the ASQ

| | *R* | $R^2$ | Beta |
|---|---|---|---|
| Step 1 | | | |
| Sleep problems → Parent-rated anxiety | .302 | .091 | .302* |
| Step 2 | .027 | .001 | .027 |
| Sleep problems → Threat bias (verbal response) | | | |
| Step 3 | .173 | .030 | -.173 |
| Threat bias (verbal response) → Parent-rated anxiety | | | |

Note * $p = .05$

## 4.5 Discussion and conclusions

Previous research has found strong associations between sleep problems and anxiety (for example, Alfano et al., 2006), and the current paper extended this research by considering whether child sleepiness, as well as child sleep problems, were associated with child anxiety. In addition, the current paper considered whether threat interpretation bias might mediate any such relationship, based on research suggesting that threat interpretation bias is often present in anxious children (for example, Creswell et al., 2005). The results of the current study suggest that parent-rated sleep problems were positively correlated with parent-rated anxiety problems in children, which gives some support to previous research findings. However, no significant correlations were found between parent- or child- ratings of current sleepiness and parent- and child- rated anxiety, or between parent-ratings of usual sleepiness and anxiety. The current paper adopted Baron & Kenny's (1986) Four Step Approach (using regression analyses) to consider whether the relationship between sleep problems and anxiety was mediated by child threat interpretation biases. However, the results of the current study did not find a mediation effect, nor did the results find parent-ratings of child anxiety to be correlated with child threat interpretation biases. Given the previous research evidence that anxiety is associated with threat interpretation bias in children (for example, Creswell & O'Connor, 2011; Creswell et al., 2005; Muris, Luermans, et al., 2000), this was a surprising result and could be explained by a number of factors. The current study used a sample of parents and children, of whom approximately half of the parents had an anxiety disorder diagnosis. Children of these parents were identified as "at-risk" of developing an anxiety disorder. Previous literature has suggested that child threat interpretation bias does not differ between non-anxious children and "at-risk" children, with a stronger threat interpretation bias found only for children with clinically diagnosed anxiety disorders (Waters, Craske, et al., 2008). Therefore, different results may have been found had a sample of clinically anxious children been used in the current study. It is possible that, by not

specifically including a sample of children with anxiety disorders, there was not sufficient variety in the levels of child anxiety across the study.

On the other hand, other studies have found that raised anxiety amongst children who do not have anxiety disorders *is* associated with threat interpretation biases (for example, Muris, Kindt, et al., 2000), and it is therefore necessary to consider alternative explanations for the non-significance of the regression analyses. Previous findings suggest that threat interpretation biases are greater when the ambiguous situation has greater salience to the child (Micco & Ehrenreich, 2008). It is possible that the children in the current study were less able to relate to the situations, which may have reduced the impact of both anxiety and sleepiness on the child's threat interpretations.

Another potential explanation is that the nature of the threat interpretation bias task may have been limited by the use of forced-choice responses. Some children may have found that neither of the forced choice options related well to how they interpreted the situation themselves. Although the current study also used free verbal responses for the ambiguous situations task, data were not available for all of the children due to a technical issue with the recording equipment. As such, the analysis based on the children's free verbal response was under-powered. Further research is required to determine whether threat interpretation bias mediates the relationship between anxiety and sleep problems (and/or sleepiness) as measured by the child's free verbal responses to the ambiguous situations.

The report of current sleepiness by both parents and children may not have included a sufficient range of sleepiness scores, which could be another explanation for the non-significant results found in the current study. For instance, all children scored between 8 and 18 out of a potential range of 6 – 30 on parent-ratings of sleepiness, indicating low levels of sleepiness for the children. The full range of scores (1-5) were scored by children for their self-rating of sleepiness, but a mean score of 2.2 also suggests that most children were not particularly sleepy at the time of testing. However, it was beyond the scope of this study to consider a sample of

clinically anxious children, or to manipulate children's levels of sleepiness. On the other hand, there was a relatively good range of scores for the parent-rating of child sleep problems (33 – 84 out of a potential of 99), with a mean score of 42.04.

In conclusion, this paper presents research that fills a gap in current literature of the impact that child sleep problems and sleepiness has on the threat interpretation bias within childhood anxiety. While a correlation was found between sleep problem scores and anxiety, thus supporting other findings within literature, the current paper did not find that threat interpretation bias mediated this relationship. However, given the surprising finding that anxiety scores were not correlated with threat interpretation bias, these non-significant findings may be due to other factors, such as insufficient variance in anxiety, sleep problems and sleepiness scores, or due to lack of personal salience of the task for the children. Further research is required, to consider whether threat interpretation bias, according to free verbal responses to ambiguous situations, mediates the relationship between child anxiety and sleep problems (and/or sleepiness).

# Chapter 5: Paper 4 - Sleepiness, anxiety and cognitive bias for emotional faces in children

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## 5.1 Abstract

Recognising and identifying emotions is crucial for the development of human relationships and interactions, yet children's anxiety can interfere with this process. In addition, and given the impact that sleep and sleep problems have on a variety of cognitive processes (such as information retrieval, attention, and emotional processes), it is possible that sleep problems or sleepiness may interfere with children's emotion recognition skills. It is important, therefore, to consider how emotion recognition processes interact with the known relationship between sleep problems and anxiety. To address this, the current study considered parent and child reports of children's anxiety symptoms, sleep problems and sleepiness. A face morph task was used to assess children's emotion recognition ability, which involved neutral facial expressions gradually increasing in intensity to display either happy or angry expressions. Children were asked to identify whether the face was a happy or angry face, as quickly as possible. Mediation analyses were conducted to explore the relationships between sleep problems, anxiety, and cognitive bias on the emotion recognition task (the difference between reaction times for recognising happy and angry facial stimuli). Although correlations were found between sleep problems and anxiety symptoms, cognitive bias did not mediate the relationship between sleep problems and anxiety. In addition, no relationships were found between child *sleepiness* and anxiety. However, these null results may be explained by the relatively low sleepiness and anxiety scores reported by parents and children. Further research is required to address this question using a sample of children with a more diverse range of symptoms.

## 5.2 Introduction

The ability to recognise complex emotions quickly and efficiently with minimal attentional focus is an integral part of social interaction and human relationships (Tracy & Robins, 2008). However, a number of factors affect the speed and efficiency of emotion recognition. For example, early childhood experiences have been associated with children's ability to identify threatening emotional expressions, with physically abused children requiring less visual input

than non-abused children to identify angry facial expressions (Pollak & Sinha, 2002). Similarly, a range of childhood psychiatric disorders are associated with differences and difficulties in facial emotion recognition, including schizophrenia, mood disorders, anxiety disorders, and attentional-deficit hyperactivity disorder (Collin, Bindra, Raju, Gillberg, & Minnis, 2013).

Anxiety disorders, and social anxiety in particular, are associated with deficits in emotion recognition, with adults who have social anxiety disorder more likely to misclassify neutral faces as angry faces (Bell et al., 2011; Mohlman et al., 2007), and adults high in trait-anxiety showing greater accuracy in the recognition of fearful emotional expressions compared with those low in trait-anxiety (Surcinelli et al., 2006). These findings suggest that adults with anxiety disorders may have a hypervigilance towards threatening emotional expressions. However, there are mixed findings for the accuracy of face recognition within the child anxiety literature. Some research suggests that levels of social anxiety predict accuracy in emotion recognition, with children who have greater social anxiety symptoms demonstrating greater accuracy (Ale et al., 2010), whereas other evidence suggests that children with anxiety disorders were equally able to identify emotional expressions in child faces, when compared with healthy controls (McClure, Pope, Hoberman, Pine, & Leibenluft, 2003). On the other hand, children with social phobia were found to make a greater number of errors in recognising happy, sad and disgust emotions in pictures of adults when compared to children without social phobia (Simonian et al., 2001). However, accuracy may be improved when children with symptoms of social anxiety are presented with child rather than adult faces (Ale et al., 2010), and both accuracy and reaction times for identifying emotional expressions have been found to improve with age (Broeren, Muris, et al., 2011).

As well as some indication that anxious children may misclassify emotions, children with anxiety disorders also appear to have an attentional bias towards threatening emotional face stimuli. For instance, more severely anxious children were found to have a greater attentional bias towards angry faces when paired with neutral faces, compared with less anxious

and non-anxious children (Krain Roy et al., 2008; Waters, Henry, Mogg, Bradley, & Pine, 2010; Waters, Mogg, Bradley, & Pine, 2008), and anxious youth made faster eye fixations to angry than neutral faces compared with non-anxious youth (Shechner et al., 2013). Gender may play a role in this process: In a study reported by Broeren et al. (2011), which used a non-clinical sample of children, girls were more vigilant towards threat stimuli, with faster reaction times towards the neutral-to-angry face morphs (in which facial expressions gradually increased in intensity from neutral to angry) compared to the neutral-to-happy face morphs (in which facial expressions gradually increased in intensity from neutral to happy), whereas boys were more avoidant of the threat stimuli, with slower reaction times towards the neutral-to-angry face morphs compared to the neutral-to-happy face morphs (Broeren, Muris, et al., 2011).

### 5.2.1 Sleep and Anxiety Research

In a review of sleep and emotion regulation research, Walker (2009) concluded that satisfactory sleep is required for optimal brain reactivity and appropriate behavioural responses towards emotional challenges faced the following day. Additionally, many cognitive processes are affected by sleep problems or sleep deprivation, including information retrieval (Mograss et al., 2009), and cognitive efficiency and attention (Acheson et al., 2007) as found in adult samples. In studies using child samples, sleep problems have been shown to affect attention and diminished learning (Beebe et al., 2010), reaction times (Sadeh et al., 2003), memory (Kopasz et al., 2010) and executive functioning (Astill et al., 2012). Emotional cognitive processes, such as identifying and processing emotions, are also affected by sleep problems, as found in a sample of adolescents (Soffer-Dudek et al., 2011). Given the range of cognitive processes that are influenced by sleep problems and sleep deprivation, and given that emotion recognition is affected by a range of factors including anxiety, it is plausible that sleepiness and sleep problems may similarly affect the processes involved in children's ability to quickly and accurately identify emotional facial stimuli. However, there is currently scarce research exploring the influence of sleepiness and sleep problems on emotion recognition or other cognitive processes involved in childhood anxiety.

Evidence also suggests that there is substantial overlap in symptoms of sleep problems and anxiety, and that symptoms of one difficulty should not be considered without also assessing symptoms of the other (Chorney et al., 2008). Similarly, there are strong associations between sleep problems and anxiety symptoms (Forbes et al., 2008; Hudson et al., 2009), with 88% of anxious children reporting at least one sleep problem, with many of these children reporting three or more (Alfano et al., 2007). It is possible, therefore, that emotion recognition biases play a mediating role in the relationship between childhood sleep problems or sleepiness and anxiety.

### 5.2.2 Current Research

The current study aimed to consider whether cognitive biases in emotion recognition, a process widely assumed to be involved in childhood anxiety, are associated with sleep problems and sleepiness, and to consider whether cognitive biases in emotion recognition interact with the relationship between sleep problems (or sleepiness) and anxiety. It was hypothesised that child sleep problems and sleepiness would be correlated with children's cognitive biases towards emotional stimuli, and that children's cognitive biases towards emotional stimuli would mediate the relationship between sleep problems and anxiety.

## 5.3 Method

### 5.3.1 Power

To achieve 80% power to detect a medium effect size ($f^2$) of 0.15, assuming an alpha of .05, 68 children were required for this study. After the exclusion of certain cases (please refer to the data preparation section), data were available for 85 children, with a power of 84% achieved.

### 5.3.2 Participants

Participants included 93 children (36% female) aged 5-9 years old (mean = 6.9 years; SD = 1.29), and their parents, recruited as part of a larger study. The majority of participants were of White British ethnic origin (86%), with other ethnic groups including White Other (4.3%),

Mixed White and Black African (1.1%), Mixed White and Asian (3.2%), Mixed Other (2.2%), Other Ethnic Group (1.1%), or undisclosed (2.2%). Approximately half of the participants were children of clinically anxious parents and were therefore classified as 'at-risk' of developing anxiety themselves ($n$ = 46), and half were children of parents who did not report suffering from anxiety disorders ($n$ = 47).

Inclusion criteria were that the parent had a child aged 5-9 years old and a good standard of English, and neither parent nor the child had major developmental or intellectual disabilities. Clinical participants (parents) were included if they had any type of anxiety diagnosis and were either referred from the local NHS services or were self-referred. Their diagnosis was verified by the Anxiety Disorder Interview Schedule (ADIS). Exclusion criteria for clinical participants included parents who lacked the capacity to consent to participation (according to referrer), and whose needs were inappropriate for a group-based intervention that was the focus of the wider study. This included a current active psychosis, severe depression, current manic state or certain severe Axis II conditions. Non-clinical participants were recruited through adverts placed in local newspapers, parenting magazines, and on the trial website, and through contacting a database of parents who had previously taken part in other developmental studies at the University (and had given consent to be contacted for future studies). Exclusion criteria for the non-clinical sample were parents who had an anxiety disorder.

Please note, parents and children included in this study participated in a number of experimental tasks. This paper reports on the results of one of these tasks, which was completed by children only. Questionnaires reported in this paper were completed by both parents and children, as specified.

### 5.3.3 Measures

#### 5.3.3.1 Demographics

Background information was collected from parents on behalf of both parent and child, including date of birth, gender, ethnicity, financial situation and parents' highest qualification.

**5.3.3.2 Anxiety Disorders Interview Schedule (ADIS) -** Brown et al. (1994)

The ADIS interview was completed by adult clinical participants to confirm their anxiety diagnosis. The following sections were used in the current study: panic disorder, agoraphobia, social phobia, generalised anxiety disorder, obsessive compulsive disorder, specific phobia, posttraumatic stress disorder, and hypochondriasis. Sections on major depressive disorder, dysthymic disorder, mania/cyclothymia, somatisation disorder, mixed anxiety/depressive disorder, alcohol abuse/dependence, substance abuse/dependence, and non-organic psychosis were excluded from the interview.

**5.3.3.3 Spence Child Anxiety Scale (parent version) (SCAS) -** Spence (1998)

A parent-rated questionnaire for an overall measure of child anxiety, including measures of panic and agoraphobia, separation anxiety, physical injury fears, social phobia, obsessive compulsive disorder, and generalised anxiety disorder / overanxious disorder. The SCAS has 38 items rated on a 4-point scale with scores of 0-3 given to responses of ‘never’, ‘sometimes’, ‘often’, and ‘always’, respectively. This measure uses a clinical cut off of 31.4 for boys, and 33 for girls. This scale has good- to excellent internal consistency, with Cronbach alphas ranging from .61 to .92 across the subscales, and has good validity indicated by strong correlations ($r$ = .55 - .59) between this scale and the internalising subscale of the Child Behaviour Checklist (Nauta et al., 2004). In addition, the SCAS shows good discriminant validity in terms of identifying children who reach clinical cut-offs for anxiety diagnoses (Nauta et al., 2004).

**5.3.3.4 Revised Children’s Anxiety and Depression Scale (child version) (RCADS) -** Chorpita et al. (2000)

A child self-rated questionnaire to measure separation anxiety disorder, social phobia, generalised anxiety disorder, panic disorder, obsessive compulsive disorder and major depressive disorder. The RCADS has 47 items rated across a 4-point scale with scores of 0-3 given to responses of ‘never’, ‘sometimes’, ‘often’, and ‘always’, respectively. A total anxiety score was computed excluding the questions referring to major depressive disorder. Good

internal consistency (alphas ranging from .73 to .82), and test-retest reliability (alphas ranging from .65 to .80) has been reported for this measure (Chorpita et al., 2000).

**5.3.3.5 Children's Sleep Habits Questionnaire (CSHQ) -** Owens et al. (2000)

This parent-rated measure of children's sleep habits and sleep difficulties includes sections on 'bedtime', 'sleep behaviour', 'waking during the night', 'morning waking', and 'daytime sleepiness'. Parents rated the items on a 3-point scale ('usually', 'sometimes', 'rarely') and indicated whether the habit was a problem or not, with a high score indicating that the habit was a problem. Total sleep problems score was based on 33 of the 48 scale items, as suggested by Owens et al. (2000), with a maximum score of 99 and a recommended clinical cut-off of 41. The total scale has acceptable internal consistency alphas of .68 based on a community sample, and .78 based on a clinical sample, and the scale has acceptable test-retest reliability with correlations ranging from .62 - .79 across the subscales (Owens et al., 2000). The scale was found to be valid in terms of distinguishing between community and clinical samples (Owens et al., 2000).

**5.3.3.6 Child Sleepiness Scale**

This scale is based on the Pediatric Daytime Sleepiness Scale (PDSS, Drake et al. 2003). The original PDSS was a child self-report measure of children's general daytime sleepiness, had a split-half reliability of .80 and .81, and was reported to be sensitive to detecting variations in sleepiness (Drake et al., 2003). The scale was adapted as a parent-reported measure of their child's sleepiness both in general and on the day of testing. To measure whether the child was sleepy on the day of testing, additional questions were used and the wording of the original questions and responses were modified so that the same responses could be used for questions about current sleepiness and usual sleepiness. It was not possible to adapt two questions from the original PDSS, and so these were excluded from the questionnaire. The adapted questionnaire had 12 items rated on 5-point scales.

**5.3.3.7 Children's Pictorial Sleepiness Questionnaire -** Maldonado et al. (2004)

Children completed this self-rated measure of sleepiness by selecting one of five pictures of increasingly sleepy faces to indicate how sleepy they felt.

### 5.3.4 Procedure

Ethical approval was received from the authors' university and the NHS Research Ethics Service. The study was explained to the parent and the child, and each gave their consent to take part. Parents and children completed the questionnaires prior to the emotion recognition task.

For the emotion recognition task, child participants completed a computer task in which they were asked to identify the emotion being displayed in short movies of morphed facial expressions. The stimuli were created by blending emotional faces (happy or angry) with neutral expressions to varying degrees (25%, 50%, 75% and 100%). Children were shown short digital movies in which a neutral face gradually changed into a full blown happy or angry emotional expression over a period of 10 seconds. Stimulus materials were taken from the NimStim (Tottenham et al., 2009) set of facial expressions, and consisted of 40 videos (20 neutral-happy; 20 neutral-angry). The task was presented in Eprime (version 2.0) on a Dell laptop. Each movie was preceded by a fixation cross for 1000ms. Children were instructed to observe the changing face and to decide, as quickly and accurately as possible, whether the emotion was changing to happy or angry by pressing an appropriate response key. Reaction times and accuracy of the children's responses were recorded.

### 5.3.5 Data preparation

The emotion recognition data were available for 93 children. The practice data of the morph task was scrutinised for errors, and data for children with more than 2 errors during this practice phase were excluded, as suggested by Broeren et al. (2011), as these children may not have fully understood or engaged with the task. After removing these data, there remained a few outlier scores for the number of errors made in the main task. A decision was made to exclude the data of children that fell outside of 2.5 standard deviations of the mean number of errors made. After

removing these outliers, morph data for the *main task* was available for 85 children, with a mean number of 2.08 errors (SD = 2.57).

## 5.4 Results

### 5.4.1 Responses to neutral-angry and neutral-happy stimuli

Paired samples t-tests were conducted to consider whether children, regardless of anxiety status, differed in their reaction times and accuracy of recognising happy versus angry facial expressions. Results suggested that children had slower reaction times towards the neutral-angry stimuli compared with the neutral-happy stimuli, suggesting that, overall, children were able to recognise happy facial expressions at a lower intensity than angry facial expressions, $t(84) = 4.22$, $p < .001$, $d = 0.27$. Differences were also found between neutral-angry and neutral-happy stimuli in terms of the average number of errors that children made during the task, with more errors found for the neutral-happy stimuli, suggesting that children were more accurate when identifying threatening emotional stimuli (angry faces) compared with the non-threatening stimuli (happy faces), $t(84) = 2.11$, $p < .05$, $d = 0.28$. See Table 5.1 for means and standard deviations.

Table 5.1 Means and standard deviations for the face morph task

| | Mean (SD) |
|---|---|
| Reaction times (happy stimuli) (milliseconds) | 5192.22 (1359.86) |
| Reaction times (angry stimuli) (milliseconds) | 5558.98 (1343.89) |
| Number of errors (happy stimuli) | 1.27 (1.82) |
| Number of errors (angry stimuli) | 0.81 (1.41) |

A one-way ANOVA was conducted to consider whether there were any significant differences in reaction times and accuracy for children 'at-risk' of anxiety compared with children of non-clinical parents, with group (at-risk children or children of non-clinical parents) entered as the independent variable, and reaction times and accuracy for the neutral-happy and neutral-angry stimuli entered as the dependent variables. The results of the ANOVA revealed no significant differences between the groups in terms of reaction times (neutral-happy: $F(1, 83) = .73$, $p = .40$; neutral-angry: $F(1,83) = .13$, $p = .73$) or for accuracy of responses on the face morph task (neutral-happy: $F(1, 83) = .03$, $p = .87$; neutral-angry: $F(1, 83) = 1.19$, $p = .28$).

### 5.4.2 Sleep and anxiety

Mean scores for children's anxiety, sleep problems and sleepiness are shown in Table 5.2. Correlational analyses were conducted to consider the relationships between the measures of sleepiness and sleep problems. Parent rated sleep problem scores were significantly correlated with both parent-ratings of current sleepiness ($r = .56$, $p < .001$) and usual sleepiness ($r = .59$, $p < .001$). Parent reports of current and usual sleepiness were significantly correlated, $r = .84$, $p < .001$. There were no significant correlations between child reports of sleepiness and parent reports of current sleepiness ($r = .19$, $p = .06$), usual sleepiness ($r = .18$, $p = .09$) or sleep problems ($r = -.06$, $p = .71$). There was a significant positive correlation between parent and child ratings of the child's anxiety symptoms, $r = .30$, $p < .01$.

Table 5.2: Descriptive statistics for the anxiety, sleep problems and sleepiness symptoms measures

| Measure | Mean (SD) | Range | Clinical cut-off |
|---|---|---|---|
| SCAS (parent-rating) | 20.03 (9.60) | 5 – 51 | 31.4 (boys)<br>33 (girls) |
| RCADS (child-rating) | 30.18 (16.52) | 0 – 85 | n/a for total score |
| Sleep problems (parent-rating) | 45.06 (9.25) | 33 – 84 | 41 |
| Usual sleepiness (parent-rating) | 11.18 (5.49) | 6 – 26 | n/a |

| | | | |
|---|---|---|---|
| Current sleepiness (parent-rating) | 10.67 (4.89) | 6 – 26 | n/a |
| Current Sleepiness (child-rating) | 2.13 (1.21) | 1 – 5 | n/a |

Key: SCAS – Spence Child Anxiety Scale; RCADS – Revised Children's Anxiety and Depression Scale

Further correlational analyses were conducted to consider the relationship between the sleepiness/sleep problem variables and anxiety. There was a significant correlation between parent ratings of child anxiety and sleep problems, $r = .39$, $p < .01$. However, parent-rated child anxiety symptoms were not correlated with parent ratings of current sleepiness ($r = .14$, $p = .22$), parent ratings of usual sleepiness ($r = .21$, $p = .07$), or child ratings of sleepiness ($r = -.00$, $p = .97$). There were no significant correlations between child-rated anxiety difficulties and any of the sleep variables. Therefore, the following analyses focus on the significant relationship between parent ratings of child anxiety and sleep problems.

### 5.4.3 Emotion recognition, child anxiety and sleep problems

Cognitive bias was calculated by subtracting the reaction time for recognising angry faces from the reaction time for recognising happy faces on the face morph task, with positive scores reflecting a bias towards angry faces (that is, a faster reaction time to detect angry emotional expressions compared with happy emotional expressions). A mediation analysis was then conducted to consider whether cognitive bias mediated the relationship between parent-reported child sleep problems and anxiety. The Four Step Approach (Baron & Kenny, 1986) using simple regression analyses for each step, was used for this analysis. For Step 1, sleep problem scores were entered as the independent variable, and anxiety scores were entered as the dependent variable. For Step 2, sleep problem scores were entered as the independent variable, and cognitive bias scores were entered as the dependent variable. For Step 3, cognitive bias scores were entered as the independent variable, and anxiety scores were entered as the dependent variable. The results of these analyses (see Table 5.3) suggested that cognitive bias did not mediate the relationship between parent ratings of sleep problems and anxiety, with no

significant results found for Steps 2 and 3. Step 4 was therefore not computed, as recommended by Baron and Kenny (1986).

Table 5.3: Mediation analysis results considering whether cognitive bias scores from the face morph task mediated the relationship between sleep problems and anxiety

| | *R* | $R^2$ | Beta |
|---|---|---|---|
| Step 1 | | | |
| Sleep problems → Parent-rated anxiety | .388 | .150 | .388* |
| Step 2 | | | |
| Sleep problems → Cognitive Bias | .043 | .002 | -.043 |
| Step 3 | | | |
| Cognitive bias → Parent-rated anxiety | .107 | .012 | -.107 |

*Note*: * $p < .01$

Similar analyses were conducted employing the difference in *accuracy* scores between neutral-happy and neutral-angry stimuli on the emotion recognition task as the measure of bias, (with the difference score calculated by subtracting accuracy scores on the neutral-angry stimuli from the accuracy scores for the neutral-happy stimuli). The same steps were used as above. The results of this analysis did not indicate a mediation effect of accuracy on the relationship between sleep problems and anxiety (see Table 5.4).

Table 5.4: Mediation analysis results considering whether the difference in accuracy between happy and angry stimuli mediated the relationship between sleep problems and anxiety

| | *R* | $R^2$ | Beta |
|---|---|---|---|
| Step 1 | | | |
| Sleep problems → Parent-rated anxiety | .388 | .150 | .388* |
| Step 2 | | | |
| Sleep problems → Difference in accuracy | .064 | .004 | .064 |
| Step 3 | | | |
| Difference in accuracy → Parent-rated anxiety | .017 | .000 | .017 |

*Note*: * $p < .01$

## 5.5 Discussion and conclusions

Based on existing evidence, suggesting that emotion recognition processes are involved in anxiety in children (Krain Roy et al., 2008; Shechner et al., 2013; Waters et al., 2010), that there is strong comorbidity between anxiety and sleep problems (Alfano et al., 2006; Chorney et al., 2008; Forbes et al., 2008; Hudson et al., 2009), and that sleep impacts on a range of cognitive processes (Acheson et al., 2007; Astill et al., 2012; Beebe et al., 2010; Kopasz et al., 2010; Mograss et al., 2009; Sadeh et al., 2003) the current study aimed to investigate whether emotion recognition processes play a mediating role in the relationship between sleep problems and anxiety. In addition to sleep *problems*, the current study considered the relationship between *sleepiness* and anxiety, and aimed to consider the role of emotion recognition bias on any relationship between these.

To explore these questions, the current paper used both child and parent-reports for the children's symptoms of sleep problems, sleepiness and anxiety. However, the results of the correlational analyses suggested that child reports of anxiety and sleepiness were not correlated with the reports given by their parents. It is difficult to determine why this may be the case, although it is suspected that many children included in this study were reluctant to say that they felt sleepy even when they did. It was noted on a number of occasions during testing that children reported no sleepiness for the questionnaires, yet at another point during the session commented that they were sleepy, or their parent commented that they seemed sleepy. This reluctance of the children to report their sleepiness may explain the discrepancy between parent and child reports. In addition, the child self-report questionnaire for sleepiness only included one pictorial item, and it may be that a greater range of questions about sleepiness would have led to greater agreement between parents and children about the children's current state of sleepiness.

As in previous research (e.g. Gregory & Sadeh, 2011), results from the current study suggested that parent reports of child sleep problems were positively correlated with symptoms

of child anxiety. However, the current study did not find significant correlations between parent or child ratings of sleepiness and anxiety symptoms, which may suggest that while sleep *problems* are associated with anxiety symptoms, sleepiness (either resulting from sleep problems or otherwise) is not. An alternative explanation could be that there was an insufficient number of children within the sample who scored high on either current or usual sleepiness. According to parent reports of child sleepiness, 86% of the children had current sleepiness scores in the lower half of the range of the questionnaire, and 83% of the children had usual sleepiness scores in the lower half of the range of questionnaire scores. This poor distribution of scores on the sleepiness questionnaire may explain the null results for the relationship between sleepiness and anxiety. Further research is required using a sample of children with a greater distribution of sleepiness scores, so that a conclusion can be drawn about the relationship between sleepiness and anxiety, if any.

The analyses for the emotion recognition task suggest that children, regardless of anxiety or sleep problems, were able to recognise the happy facial expressions at a lower intensity than the threatening stimuli (angry faces), as demonstrated by slower reaction times for identifying the emotions for the neutral-angry stimuli compared with the neutral-happy stimuli. This finding has also been reported in other studies, (for example, Broeren et al., 2011).

Given the lack of significant differences in reaction times and accuracy on the face morph task between the children of clinically anxious parents and children of non-clinical parents, these findings seem to be representative of both the ‘at-risk’ sample of children and the non-clinical children. This may suggest that there is little difference in emotional stimuli processing for children at-risk of developing anxiety disorders and children from a non-clinical population. Further research could additionally consider a sample of children with clinical diagnoses of anxiety to see if similar results are found. This lack of difference between the ‘at-risk’ sample and the non-clinical sample for the emotion recognition task may also explain the non-significant results found for the mediation analysis. There was limited variability in parent-

rated child anxiety, with 86% of the children scoring below 31, which represents the norm mean score for children with anxiety disorders (Nauta et al., 2004). It appears, therefore, that the sample recruited for this study had fairly low anxiety levels, and further research is required to consider the mediating effect of emotion recognition biases between sleep problems and anxiety on a sample reporting greater anxiety problems. Indeed, it was interesting that the analyses did not reveal any relationship between cognitive bias on the face morph task and parent-rated child anxiety, particularly given previous research showing that anxiety difficulties can lead to greater attentional biases towards threat emotions (for example, Krain Roy et al., 2008). It may be that the sample of children used in the current study simply did not have high enough levels of anxiety in order for an effect to be found.

In conclusion, the current study attempts to address an important gap in the literature by considering whether there is a relationship between sleep problems and cognitive bias in an emotion recognition task, as well as considering how emotion recognition, a process known to be involved in childhood anxiety, plays a role in the relationship between sleep problems and anxiety. Unfortunately there was an insufficient range of severity of sleepiness or anxiety difficulties in the sample of children, with the majority scoring relatively low on each of these symptoms. Further research, using a more diverse sample, is required to consider whether sleepiness is related to childhood anxiety symptoms, and to consider whether processes involved in childhood anxiety, such as emotion recognition, play a role in this relationship and in the relationship between sleep problems and anxiety.

# Chapter 6: Paper 5 - The impact of sleepiness on children's anxious behaviours

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## 6.1 Abstract

**Background:** Childhood anxiety disorders are highly comorbid with sleep problems, yet it is currently unknown how child *sleepiness* affects the processes involved in childhood anxiety. The current paper uses three studies to consider the effect of sleepiness and reduced sleep on children's behavioural responses when exposed to anxiety-provoking stimuli. **Method:** Study 1: Children reported on their symptoms of anxiety and sleepiness, and engaged in two behavioural tasks to assess their approach/avoidance behaviours. In the first task, children chose how close to stand while a balloon was burst, and in the second task, children were asked to burst the balloon. Distance from the balloon and time to burst the balloon were measured. Testing was repeated one week later. Study 2: The protocol for Study 1 was repeated. In addition, parents completed questionnaires about their children's symptoms of anxiety and sleepiness, and children had their sleep reduced by 2 hours at either Time 1 or Time 2. Study 3: The protocol for Study 1 was repeated, with the exceptions that testing sessions were repeated a few hours apart rather than a week apart, and that the 'time to burst the balloon' task was omitted. **Results:** Study 1: Children with greater current states of sleepiness stood closer to the balloon. Children with greater usual (or trait) sleepiness stood further away from the balloon. No correlations were found between sleepiness and time taken to burst the balloon. Children who were sleepier at Time 1 habituated less well to the distance task. Study 2: Children with reduced sleep stood significantly closer to the balloon than when they had normal sleep. No effect of reduced sleep was found for the 'time to burst the balloon' task. Children who were in the sleep reduction condition at Time 1 habituated less well to the distance task than children who received the sleep reduction at Time 2. Study 3: No correlations were found between current or usual sleepiness and the distance children stood from the balloon at either time point. Sleepier children habituated more to the distance task than less sleepy children. **Conclusions:** Children's increased sleepiness or reduced sleep may interfere with children's approach of anxiety-provoking stimuli. It is possible that sleepier children were less anxious about exposures to anxiety provoking stimuli and, therefore, showed greater approach towards the stimuli for their

first exposure to it. Having a week between exposures, rather than repeat exposures on the same day, may reduce children's effectiveness at habituating to the task. Further research is required to explore these findings.

## 6.2 Introduction

Anxiety disorders are one of the most prevalent childhood psychological disorders, with reports of prevalence rates falling in the range of 3% to 24% for any type of childhood anxiety disorder diagnosis (Cartwright-Hatton et al., 2006). Data from longitudinal cohort studies suggest that about a third of adults with anxiety disorders had these before the age of 15 (Gregory et al., 2007), while those diagnosed with anxiety in childhood were three times more likely to have a diagnosis at adolescence, and those diagnosed in adolescence were three times more likely to have a diagnosis in early adulthood (Copeland et al., 2013).

Childhood anxiety disorders are highly comorbid with sleep problems, with 83-90% of children with anxiety disorders also reported to suffer from at least one sleep complaint (Alfano et al., 2006; Chase & Pincus, 2011), with an additive risk of sleep problems found for children with more than one anxiety diagnosis (Chase & Pincus, 2011). Children with social phobia, separation anxiety disorder and generalised anxiety disorder were most likely to report comorbid sleep problems, with over 90% of children with each of these disorders additionally experiencing at least one sleep problem (Chase & Pincus, 2011). Child sleeping difficulties are also strongly associated with anxiety and depression symptoms (Johnson et al., 2000). Other research findings suggest that early sleep problems may predict difficulties with anxiety later in life (Gregory & O'Connor, 2002; Gregory et al., 2005; Jansen et al., 2011; Touchette et al., 2012), with poor regularity of sleeping habits in childhood predicting the onset of anxiety during adolescence (Ong et al., 2006).

Existing research has so far focused only on trait sleep *problems*, and there is little research that has considered the association between state *sleepiness* and anxiety. Given the strong associations between sleep problems and anxiety, it is plausible that a child's sleepiness,

as well as *sleep problems*, may have an effect on anxiety; indeed, children with social phobia reported increased tiredness and fatigue (Chase & Pincus, 2011), and children who had less sleep had an increased risk of suffering from anxiety in later childhood or adolescence compared to those who slept more (Silva et al., 2011). Other research on sleep patterns of clinically anxious children has shown that anxious children go to bed significantly later than non-anxious children (Hudson et al., 2009). However, to the authors' knowledge, there is no research that considers the impact of state *sleepiness* on the processes involved in childhood anxiety, including social, cognitive and behavioural processes. However, there is substantial evidence to suggest that poor sleep negatively affects a number of cognitive processes, including memory (Kopasz et al., 2010), executive functioning (Astill et al., 2012), and emotional processing (Hu et al., 2006; Nishida, Pearsall, Buckner, & Walker, 2009). The current paper considers the effect of sleepiness on children's anxious behaviours, specifically the avoidance of, and habituation towards, anxiety-provoking stimuli.

Avoidance of feared stimuli is a key feature of anxiety, with substantial evidence to suggest that anxiety and avoidance of anxiety-provoking stimuli go hand in hand. For instance, spider fearful children avoid both looking at spiders and approaching spiders, with more avoidance found for children more fearful of spiders (A. Klein et al., 2011). In addition, children given verbal threat information (as opposed to no information) about novel animals showed greater avoidance of the animals in a behavioural avoidance task (Field et al., 2008). Similarly, anxious children avoided looking at angry and fearful faces in a dot-probe task (Stirling et al., 2006), and were more likely than non-anxious children to avoid choosing colours paired with images of angry faces, even if this reduced the number of points that the children scored in a game (J. Lau & Viding, 2007).

However, avoidance of feared stimuli can hinder recovery: it prevents the individual from challenging their fears, and negative reinforcement of the avoidance behaviour is provided by the short-term relief that avoidance achieves (Eifert & Forsyth, 2005). On the other hand,

repeated exposure to an anxiety-provoking stimuli can lead to a habituation effect in terms of reduced levels of reported fear and anxiety (Forsyth, Lejuez, & Finlay, 2000; Olatunji et al., 2009). For instance, in a sample of adults with fears of contamination, repeated exposure to threat-relevant stimuli reduced reported fear (but not disgust) in the participants (Olatunji et al., 2009). Other research has used carbon dioxide enriched air or fast breathing to induce panic-like sensations in non-clinical and anxiety-sensitive adult populations, and found that although the participants did not habituate to the task itself (in terms of inducing a hyperventilation response), the participants did demonstrate a habituation effect in terms of reduced anxiety reported during the task (Carter, Watt Marin, & Murrell, 2000; Forsyth et al., 2000). The same effect is apparent for children. Exposure has been shown to result in habituation towards children's fears, and repeated exposure to feared stimuli is central to all cognitive-behavioural interventions for anxiety (Kendall, 1994; Silverman et al., 1999).

### 6.2.1 Current Studies

There is no research (to the authors' knowledge) that considers how sleepiness affects children's anxious behaviours or the processes involved in childhood anxiety, such as avoidance and habituation. Considering the reports that sleep disorders are associated with anxiety (Alfano et al., 2006; Chase & Pincus, 2011; Gregory & O'Connor, 2002), it seems plausible that sleepiness and reduced sleep may have an effect on children's behaviours towards anxiety-provoking stimuli. The studies described in this paper, therefore, aimed to address this through exploring the effect that child sleepiness and reduced sleep has on avoidance and habituation processes. However, it should be noted that the initial aim of the first two studies was to explore the effect of reduced sleep on children's avoidance behaviours and not, initially, to address habituation processes. Study 1 was a pilot study, primarily designed to consider the suitability of the measures and behavioural tasks with which this question would be addressed. In addition, however, it was possible to use this study to conduct a preliminary exploration of whether child sleepiness was associated with increased avoidance. From the results of these exploratory analyses, however, interesting questions arose about the role of children's sleepiness on their

habituation towards the task, and the pilot data was again used to conduct a preliminary exploration of this question. The initial aim of the second study was to explore the effect of reduced sleep on children's avoidance behaviour, and it was decided that the order that children received the sleep reduction should be counterbalanced, so that any order effects could be identified and accounted for. Unfortunately, the data from Study 1 were not available prior to the design of Study 2 and its counter-balanced design was not ideal for addressing habituation, since there was no control group who received normal sleep at both time points. Nonetheless, it was possible to conduct a preliminary exploration of the effect of reduced sleep on children's habituation to the task. Thus, both Studies 1 and 2 considered the effect of sleepiness (or reduced sleep) on avoidance and habituation of anxiety-provoking stimuli with two exposures to the fearful stimuli set a week apart. Study 3 was then developed to consider the effect of sleepiness on avoidance and habituation when the exposure to the anxiety-provoking stimuli occurred on the same day, a few hours apart. It was hypothesised that increased sleepiness (Studies 1 and 3) and reduced sleep (Study 2) would be positively correlated with fearful behaviours during the behavioural tasks: that is, sleepier children would be more avoidant of the behavioural tasks. It was also hypothesised that sleepiness and reduced sleep would negatively affect children's habituation towards the task when repeated.

## 6.3 Study 1 – Pilot Study

### 6.3.1 Method

#### *6.3.1.1 Power*

This study was designed primarily as a pilot study to test and refine behavioural tasks for Studies Two and Three. However, for the secondary aim of conducting a preliminary exploration of the association between sleepiness and exposure to fearful stimuli, it was calculated that (based on the analyses that required the most power), 67 children were required for a power of 80% to detect a medium effect size of 0.3, assuming an alpha of .05. According

to these criteria, and based on the sample of 35 participants in this study, a power of 57% was achieved.

#### *6.3.1.2 Participants*

Thirty-five children were recruited from two schools in the South-East of England. Two of these children dropped out of the study (1 child was absent on the day of testing; 1 child declined participation), leaving a sample of 33 children from school years 3-5, aged 7-10 years (51.5% female). The mean age of the children was 8.52 years (SD = 0.87). The school year groups were chosen for similarity to the ages of children used in parallel studies. For the follow-up part of this study, 32 children continued participation (1 child was absent on the day of testing). The children met the following inclusion criteria: attended one of the recruited schools at the time of testing; aged 7-10 years; spoke at least moderately good English; and able to commit to the two testing sessions. Children were excluded from the study if they had a moderate to severe developmental disorder, as determined by parents at the time of consent.

#### *6.3.1.3 Measures*

**Child Sleepiness Scale**

The child sleepiness scale is based on the Pediatric Daytime Sleepiness Scale (PDSS, Drake et al., 2003), which is a validated child-rated measure of general symptoms of sleepiness containing 8 items. The PDSS had a split-half reliability of .80 and .81, and was reported to be sensitive to detecting variations in sleepiness (Drake et al., 2003). This measure was used to assess children's 'usual sleepiness' for the current study, although the wording of the questions and the response scale were adapted so that additional questions could be added to measure sleepiness at the time of testing ('current sleepiness'), for example "how sleepy have you been during class today?" The adapted questionnaire had 16 items (8 items to measure 'usual sleepiness' and 8 to measure 'current sleepiness') and was administered at both Time 1 and Time 2. Cronbach's alpha was used to determine the internal consistency of the adapted sleepiness questionnaire, and the questionnaire as a whole, was found to have high internal

consistency, α = .847, and high internal consistency was found for both the 'usual sleepiness' scale (α = .777) and for the 'current sleepiness' scale (α= .704). The test-retest reliability of the 'usual sleepiness' scale was satisfactory, $r = .63$, $p < .001$, but poor for the 'current sleepiness' scale, $r = .23$, $p > .05$. However, it was expected that current levels of sleepiness would naturally differ across two time periods, and so this low correlation was not considered problematic.

**Multidimensional Anxiety Scale for Children – 10 (MASC-10) –** J. March, Parker, Sullivan, Stallings, and Conners (1997)

The MASC-10 is a well-validated and reliable measure of severity of anxiety problems in children. The MASC-10 has good test-retest reliability, with intraclass correlation coefficients of .86 (J. March, Sullivan, & Parker, 1999). Since it was unlikely that the child's trait anxiety would change substantially between the two time points, the MASC was only administered at Time 1 for the current study.

#### *6.3.1.4 Procedure*

Ethical approval was obtained from the university research ethics committee. Schools were approached and invited to engage in the research study. On agreement from the school, information about the study was provided to the parents of children in school years 3-5. Children who were willing, and had the consent of their parents, were invited to take part in the study. Testing for this study was conducted at two time points, one week apart.

At Time 1, children gave their consent before completing the questionnaires on anxiety symptoms and sleepiness. Two behavioural tasks were then completed. For these, children were individually taken to a quiet area, and the tasks were conducted in a predetermined random order (determined by a computerised random number generator). These tasks were as follows:

1. Asking a child to choose how far away to stand while a balloon was burst by the researcher. Distance stood from the balloon being burst by the researcher was measured using a tape measure and taken as an indication of the child's fear of the task.

2. Asking a child to burst a balloon using a pin. The time taken to burst the balloon (up to a maximum of two minutes) was recorded using a stop-watch and taken as an indication of the child's fear of the task.

In each task, balloon size was standardised using a size gauge to ensure consistency in the level of sound produced when burst. At the second testing session, the procedure was repeated as at Time 1, although children were not asked to re-complete the MASC-10 questionnaire. Children verbally gave consent to continue with their participation in the study at Time 2.

#### *6.3.1.5 Data analysis*

The primary aim of this study was to test the behavioural tasks and, in particular, to find out whether they were resistant to practice effects, so that further studies could consider any differences in task performance across repeated performances. The results of the behavioural tasks were tested for differences in the children's performance across time, with significant changes in performance indicating practice effects. Correlational analyses were conducted to find out whether the MASC-10 scores correlated with outcomes on the behavioural tasks, where positive correlations would indicate that the tasks were a suitable behavioural measure of anxiety. Reliability and validity tests were employed for the adapted child sleepiness scale. In addition, and to explore the secondary question, correlational analyses were conducted to consider the relationship between sleepiness scores and performance on the behavioural tasks at Time 1 and Time 2.

### 6.3.2 Results

#### *6.3.2.1 Primary Question – Are the behavioural measures appropriate for repeat testing?*

#### 6.3.2.1.1 Practice Effects

Paired-samples t-tests were used to assess practice effects for the behavioural tasks in this study. The results of these t-tests indicated that the task in which children chose how close to stand to the balloon being burst by the researcher was not resistant to practice effects, with results indicating a significant reduction in the distance the child stood from the balloon from Time 1 to Time 2, $t(31) = 3.53$, $p < .001$, $d = 1.25$. However, the time taken for the child to burst the balloon themselves was found to be resistant to practice effects across the two sessions, $t(31) = -1.12$, $p = .27$, $d = -0.39$. See Table 6.1 for means and standard deviations.

Table 6.1: Means and standard deviations for the behavioural tasks at Time 1 and Time 2

| | TIME 1<br>Mean (SD) | TIME 2<br>Mean (SD) |
|---|---|---|
| Distance stood from balloon being burst (inches) | 82.63 (62.06) | 45.31 (52.40) |
| Time for child to burst the balloon (seconds) | 4.49 (3.44) | 6.03 (8.23) |

#### 6.3.2.1.2 Validity

To assess the validity of the behavioural tasks as behavioural measures of children's anxiety, correlational analyses between outcomes on these tasks and a measure of anxiety (MASC-10) were conducted. There were positive but non-significant correlations between the MASC-10 and the distance children stood from the balloon at Time 1 ($r = .33$, $p = .06$), and between the MASC-10 and the time it took for children to burst the balloon at Time 1 ($r = .30$, $p = .09$).

#### 6.3.2.1.3 Associations between ratings of anxiety and sleepiness

Significant, positive correlations were found between anxiety (MASC-10) and children's total 'usual sleepiness' score at Time 1 ($r = .44$, $p < .01$) and between anxiety and the children's total 'current sleepiness' score at Time 1 ($r = .40$, $p < .05$).

### *6.3.2.2 Secondary Question 1 – How does sleepiness affect children's avoidance in the behavioural tasks?*

#### 6.3.2.2.1 Current sleepiness and the time children took to burst the balloon

To consider this secondary question, correlational analyses were conducted between Time 1 current sleepiness scores and both Time 1 and Time 2 scores of the time children took to burst the balloon, and between Time 2 current sleepiness scores and the time children took to burst the balloon at Time 2. Time 1 current sleepiness was not correlated with time taken for the child to burst the balloon at Time 1 ($r$ = .06, $p$ = .75), or at Time 2 ($r$ = -.16, $p$ = .37). This is illustrated in Figure 6.1. Time 2 current sleepiness was not correlated with time taken for the child to burst the balloon at Time 2 ($r$ = -.10, $p$ = .61).

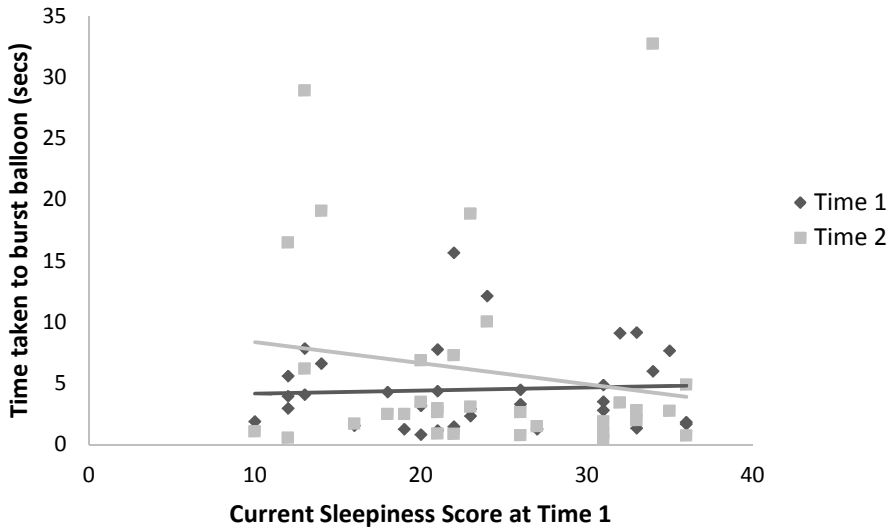


*Figure 6.1: The relationship between current sleepiness scores at Time 1 and time (in seconds) the child took to burst the balloon at Time 1 and Time 2*

#### 6.3.2.2.2 Usual Sleepiness and the time children took to burst the balloon

To consider the relationship between usual sleepiness and the time children took to burst the balloon, correlational analyses were conducted as described above for current sleepiness. Time 1 usual sleepiness was not correlated with time taken for the child to burst the balloon at Time 1 ($r$ = .14, $p$ = .43) or at Time 2 ($r$ = -.02, $p$ = .93). This is illustrated in Figure 6.2. There was a

negative but non-significant correlation between Time 2 usual sleepiness and time taken for the child to burst the balloon at Time 2 ($r$ = -.32, $p$ = .08), with more sleepy children taking less time to burst the balloon.

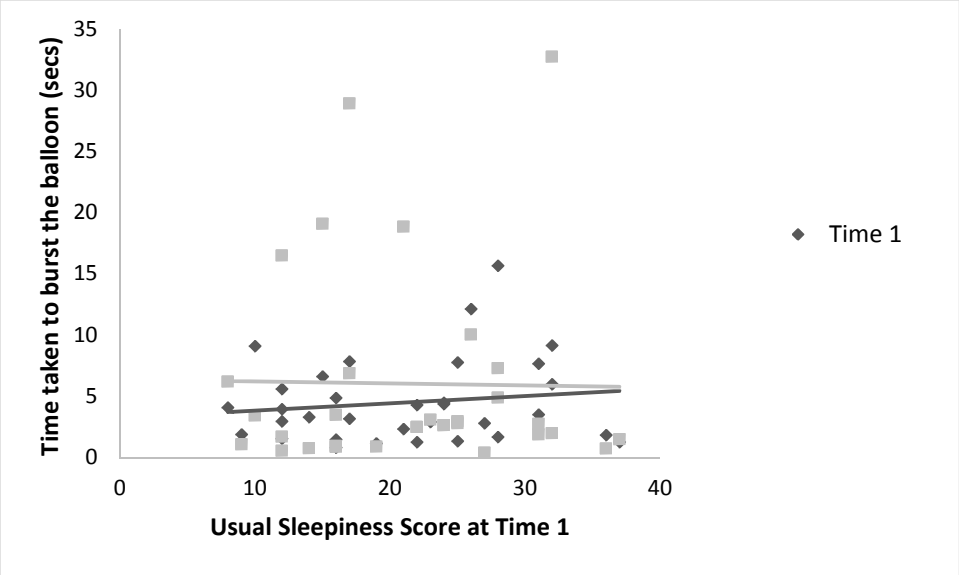


*Figure 6.2: The relationship between usual sleepiness scores at Time 1 and time (in seconds) the child took to burst the balloon at Time 1 and Time 2*

**6.3.2.2.3 Current Sleepiness and the distance children stood from the balloon being burst**

As for the 'time to burst the balloon' task, correlational analyses were conducted to consider the relationship between Time 1 current sleepiness and children's distance from the balloon at both Time 1 and Time 2, and between Time 2 current sleepiness and the children's distance from the balloon at Time 2. A negative correlation, which approached significance, was found between current sleepiness at Time 1 and distance from the balloon being burst by the researcher at Time 1 ($r$ = -.34, $p$ = .05), with those scoring higher on sleepiness standing closer to the balloon being burst. Current sleepiness at Time 1 was not significantly correlated with children's distance from the balloon at Time 2 ($r$ = .09, $p$ = .61). These findings are illustrated in Figure 6.3. Likewise, current sleepiness at Time 2 was not correlated with distance from the balloon being burst by the researcher at Time 2 ($r$ = .18, $p$ = .32).

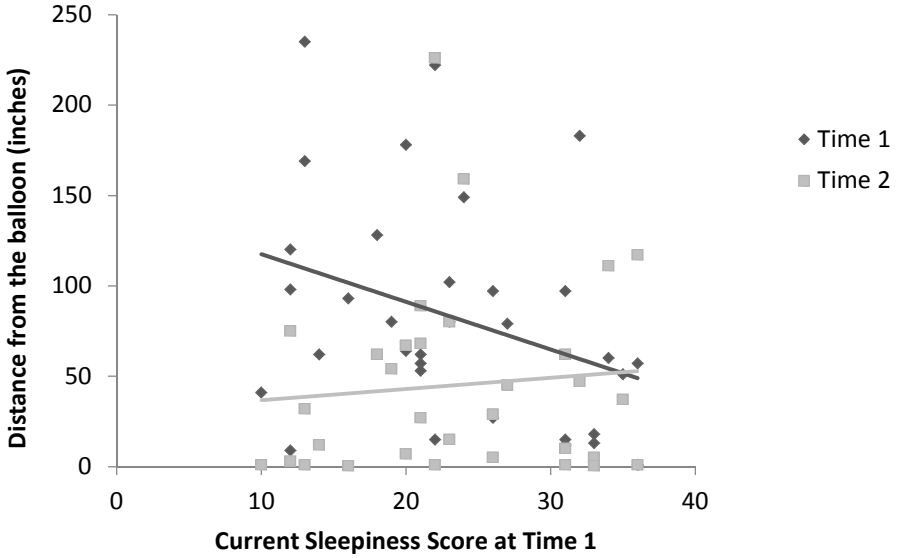


*Figure 6.3: The relationship between current sleepiness scores at Time 1 and distance (in inches) from the balloon being burst by the researcher at Time 1 and Time 2*

**6.3.2.2.4 Usual Sleepiness and the distance children stood from the balloon being burst**

No significant correlations were found between the child's usual sleepiness score at Time 1 and the distance stood from the balloon at Time 1 ($r$ = -.21, $p$ = .24). A correlation that approached significance was found between children's usual sleepiness score at Time 1 and the distance stood from the balloon at Time 2 ($r$ = .35, $p$ = .05), with children with greater usual sleepiness scores at Time 1 standing further away from the balloon being burst at Time 2. This is illustrated in Figure 6.4. There was a significant, positive correlation between usual sleepiness at Time 2 and distance from the balloon being burst by the researcher at Time 2 ($r$ = .35, $p$ < .05), with children with greater scores for usual sleepiness standing further away from the balloon being burst.

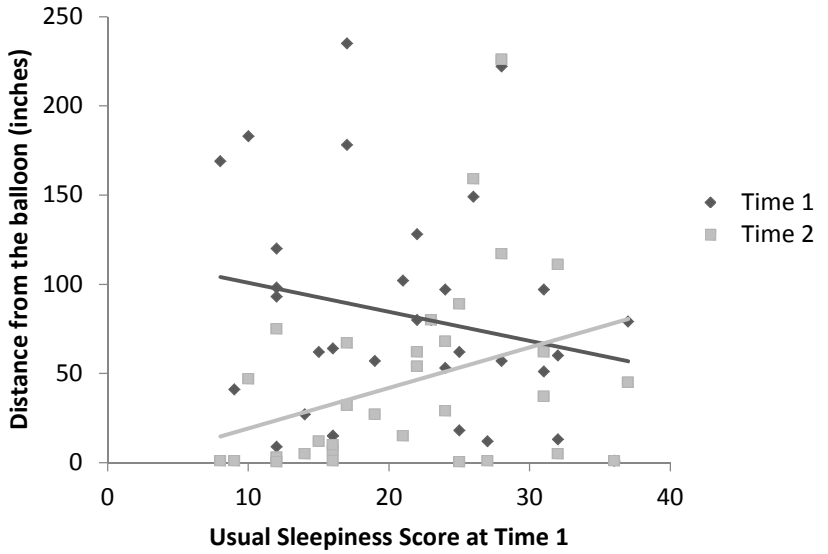


*Figure 6.4: The relationship between usual sleepiness scores at Time 1 and distance (in inches) from the balloon being burst by the researcher at Time 1 and Time 2*

#### *6.3.2.3 Secondary Question 2 – How does sleepiness affect children's habituation to the behavioural tasks?*

Given that the distance the child stood from the balloon was vulnerable to practice effects, it was possible to consider the relationship between sleepiness and children's habituation to this task. Correlational analyses were conducted to examine the relationship between sleepiness (at Time 1 only) and proportional change in distance from the balloon being burst by the researcher at Time 1 and Time 2. Change in distance score was calculated by subtracting the distance score at Time 2 from the distance score at Time 1, dividing the result by the distance score at Time 1, and multiplying by 100%. The resulting score represented the proportion closer to the balloon that the child stood at Time 2 compared to Time 1, with a larger score representing a greater reduction in distance from the balloon at Time 2 compared to where the child stood at Time 1. Results of these analyses indicated that Time 1 current and usual sleepiness were negatively correlated with how much closer the children stood to the balloon at Time 2 (current: $r = -.39$, $p < .05$; usual: $r = -.54$, $p < .001$), with more sleepy children (according to both current and usual sleepiness ratings) reducing their distance from the balloon (and thus apparently habituating to

the task) significantly less than the children who reported less current and usual sleepiness (see Figures 6.5 and 6.6).

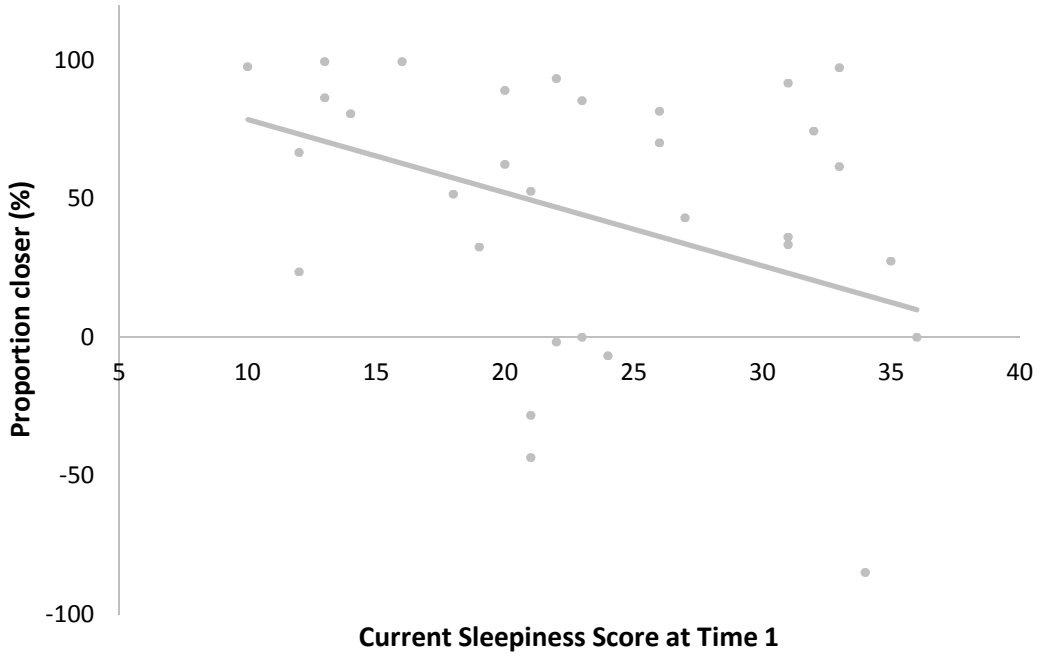


*Figure 6.5: Relationship between current sleepiness and the proportion closer that the child stood to the balloon at Time 2 in comparison to Time 1.*

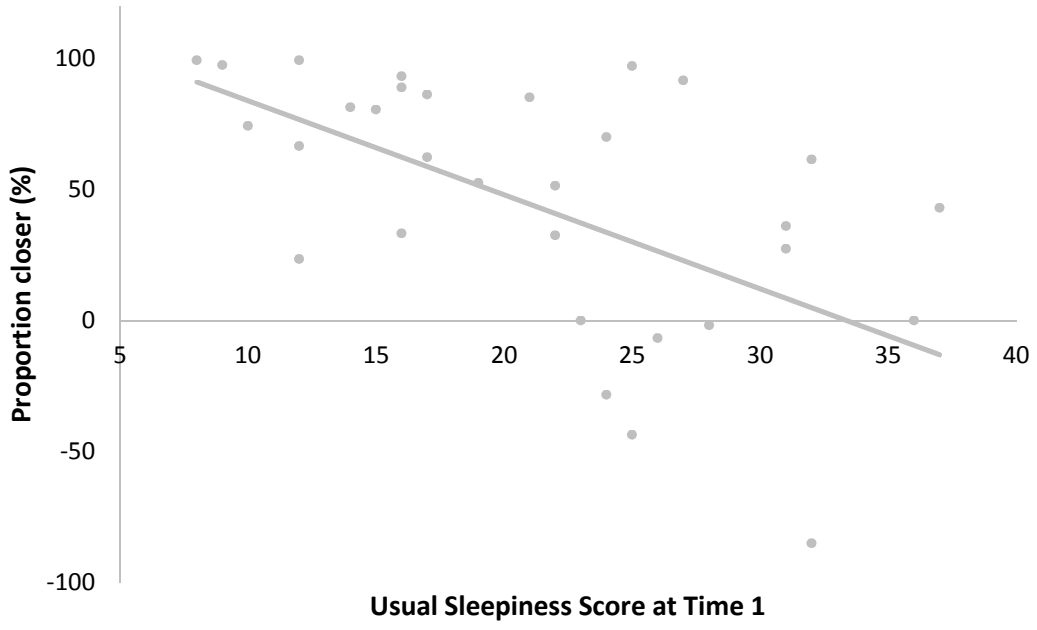

*Figure 6.6: Relationship between usual sleepiness and the proportion closer that the child stood to the balloon at Time 2 in comparison to Time 1.*

### 6.3.3 Study One Discussion

#### *6.3.3.1 Primary study aims*

The primary aim of Study 1 was to test the suitability of the study design for use over two testing time points so that a subsequent study could assess the effects of sleep on children's responses to the task both in a 'reduced sleep' condition and a 'normal sleep' condition. Firstly, results from Study 1 indicate that there are associations between child sleepiness and anxiety, suggesting that further exploration of the associations between sleepiness (and reduced sleep) and children's anxiety would be useful.

Secondly, the behavioural task of 'time taken for the child to burst a balloon' was resistant to practice effects, which suggests that this was an appropriate task to use for testing across two time points. However, there was a small change across these time points, which needs to be taken into consideration. On the other hand, the behavioural task of 'distance stood from the balloon being burst' was not resistant to practice effects. Although this rendered this task inappropriate for its original purpose, as children habituated to this task across the two testing sessions, it did allow the task to be used to explore the impact of child sleepiness on habituation towards anxiety-provoking stimuli.

Thirdly, both the behavioural measures (time taken to burst a balloon and distance stood from a balloon being burst), approached significance in their correlations with the children's self-report of their anxiety levels, suggesting that these tasks *may* be valid anxiety-provoking behavioural tasks. It is possible that these correlations did not reach significance because anxious children are not necessarily scared of balloons being burst, but it is also likely due to lack of power in this study. A decision was therefore made to add a self-report measure of children's 'fear of a balloon being burst' to Studies 2 and 3, to further consider the validity of this task.

#### *6.3.3.2 Secondary study aims*

Interestingly, few significant correlations were found between sleepiness (current and usual) and the time that it took children to burst the balloon. Indeed, the only correlation that approached significance was between usual sleepiness at Time 2 and the time taken to burst the balloon at Time 2. These mainly non-significant findings may suggest that children's sleepiness is not associated with children's avoidance in terms of delaying the bursting of the balloon. It is worth noting, though, that this analysis was underpowered, and relationships may have been found had a larger sample been adopted. However, as addressing this question was not the primary aim of this study, a decision was made to use the data available to consider whether any trends emerged.

Relationships were found between children's sleepiness and the distance that children stood from the balloon, which may suggest that this task is more suitable than the 'time to burst the balloon' task for identifying the relationship between sleepiness and avoidance. Interestingly, the direction of the relationship between *current sleepiness* at Time 1 and children's distance from the balloon at Time 1 was counter to that hypothesised, with more sleepy children standing closer to the balloon being burst. On the other hand, the direction of the relationship between *usual sleepiness*, both at Time 1 and at Time 2, and distance stood from the balloon at Time 2 was in the expected direction, with more sleepy children standing further away from the balloon. This finding may suggest that, while current states of sleepiness are not associated with children's avoidance of anxiety-provoking situations, usual (or trait) sleepiness may be. However, further research is required to explore this finding, using a larger sample size.

As the distance children stood from the balloon was not resistant to practice effects, it was possible to consider an additional research question of how sleepiness affects children's habituation to this task. The results from these analyses suggest that, in general, children habituated to this task across the two testing sessions. However, as children's ratings of their *usual sleepiness* increased, their effectiveness at habituating to the task decreased, with the

children with the highest reports of usual sleepiness showing less reduction in distance stood from the balloon being burst than those with lower ratings of sleepiness. This finding suggests that increased levels of usual sleepiness at Time 1 may have inhibited the children's habituation to the task one week later. Similarly, as children's ratings of their *current* sleepiness increased, their effectiveness at habituating to the task decreased, with the more sleepy children showing less reduction in distance from the balloon compared to the less sleepy children. These results suggest that the sleepier the children were at Time 1 (either currently or usually), the less positive change they showed in the distance they stood from the balloon being burst. However, for *current sleepiness*, the sleepier the children were at Time 1, the closer they stood to the balloon at Time 1. Therefore, it is possible that the sleepy children simply had less room for improvement at Time 2, rather than that they habituated less well to the task.

Unfortunately because of the small sample used in this pilot study, the analyses for the secondary questions were under-powered. Therefore, further research is required before conclusions can be drawn about the impact of children's sleepiness on their anxious behaviours. Overall, however, the results of Study 1 suggest that *usual sleepiness*, in particular, may negatively affect children's ability to habituate to anxiety provoking stimuli, which is an area that requires further investigation using a larger sample.

## 6.4 Study 2

Study 2 explored the impact of reduced sleep on children's sleepiness, and on their subsequent responses to the behavioural tasks.

### 6.4.1 Method

#### *6.4.1.1 Power*

Based on the analyses that required the most power in this study, 67 children were required for a power of 80% to detect a medium effect size of 0.3, assuming an alpha of .05. According to

these criteria, and based on the sample of 21 participants for this study, a power of 40% was achieved.

#### *6.4.1.2 Participants*

Participants included 21 children (33% female) aged 7-10 years old (mean = 8.57 years; SD = .87) recruited from community groups such as Brownie Guide or Cub Scout Packs in the South East of England, and through approaching previous (adult) participants of a parallel study to invite them to include their children in the study. The age range of participants was chosen for similarity with other studies in this field. The inclusion criteria were that the children were aged from 7 to 10 years, spoke at least moderately good English, and were able to commit to the two testing sessions. Children were excluded from the study if they had a moderate to severe developmental disorder, as determined by their parents at the time of consent.

#### *6.4.1.3 Measures*

**Child Sleepiness Scale**

Adapted from the Pediatric Daytime Sleepiness Questionnaire (Drake et al., 2003) as described for Study 1.

**Multidimensional Anxiety Scale for Children – 10 (MASC-10) –** J. March et al. (1997)

As described for Study 1.

**Fear of balloons bursting (self-report**)

Children rated how scared they were of a balloon being burst on a 5-point scale, with low scores representing little fear about the balloon bursting, and high scores representing a lot of fear about the balloon bursting. This measure was additional to the measures used in Study 1.

**Child Sleepiness Scale – Parent-Rating**

As for the child-rated version of this measure, this scale was based on the Pediatric Daytime Sleepiness Scale (PDSS, Drake et al. 2003). The original PDSS was a child self-report measure

of children's general daytime sleepiness, had a split-half reliability of .80 and .81, and was reported to be sensitive to detecting variations in sleepiness (Drake et al., 2003). The scale was adapted for the current study as a parent-reported measure of their child's sleepiness both in general ('usual sleepiness') and on the day of testing ('current sleepiness'). To measure the children's current sleepiness, additional questions were used and the wording of the original questions and responses were modified so that the same responses could be used for questions about current sleepiness and usual sleepiness (as also adapted in the child-rated version). It was not possible to adapt two questions from the original PDSS in this way, and so these were excluded. The adapted questionnaire had 12 items rated on 5-point scales.

**Spence Child Anxiety Scale (SCAS) parent version -** Spence (1998)

A parent-rated questionnaire for an overall measure of child anxiety, including measures of 'panic and agoraphobia', 'separation anxiety', 'physical injury fears', 'social phobia', 'obsessive compulsive disorder', and 'generalised anxiety disorder/overanxious disorder'. The SCAS has 38 items rated on a 4-point scale ('never', 'sometimes', 'often', 'always'). This measure uses a clinical cut off of 31.4 for boys, and 33 for girls. This scale has good- to excellent internal consistency, with Cronbach alphas ranging from .61 to .92 across the subscales, and has good validity indicated by strong correlations ($r$ = .55 - .59) found between this scale and the internalising subscale of the Child Behaviour Checklist (Nauta et al., 2004). In addition, the SCAS shows good discriminant validity in terms of identifying children who reach clinical cut-offs for anxiety diagnoses (Nauta et al., 2004).

#### *6.4.1.4 Procedure*

Ethical approval was obtained as for Study 1. Recruitment of participants for Study 2 included sending out letters and information sheets to parents of children in the community groups, and contacting parents who had previously taken part in a parallel study by email. Testing was conducted at two time points, approximately one week apart. Parents returned consent forms

prior to the first testing session, and children gave written consent at the beginning of the first testing session.

The primary aim of Study 2 was to explore the impact of sleepiness on children's approach to two fearful stimuli (balloons bursting). It was conducted over two sessions, one of which included a sleep reduction manipulation, where parents were asked to keep their child up for two hours later than their usual bedtime prior to one of the two testing sessions (randomly selected). This was so that children's responses to the behavioural tasks when they were sleepy and when they were not sleepy could be directly compared. The order in which children had reduced and normal sleep was counterbalanced so that order effects could be accounted for. Prior to the first session, parents were informed which testing session would involve the sleep reduction. Approximately half of the children stayed up late the night before the first session, and approximately half stayed up late the night before the second session, which was verbally confirmed by parents prior to each session.

At Time 1, children completed the child-rated questionnaires in small groups, either within the community group setting, or in the university laboratory, and parents completed the parent-rated questionnaires. Children then individually participated in the two behavioural tasks used in Study 1: choosing where to stand while a balloon was burst by the researcher; and the children bursting a balloon themselves. As in Study 1, the size of the balloon was standardised using a gauge. Distance stood from the balloon being burst by the researcher, and time taken to burst the balloon were measured.

At Time 2 (one week later), child- and parent-rated measures of sleepiness and children's fear of a balloon being burst were repeated. The MASC-10 and SCAS anxiety questionnaire measures were not repeated at Time 2. Children then individually repeated the behavioural tasks.

#### *6.4.1.5 Data Analysis*

Initial correlational analyses were conducted to explore the agreement between parents and children in terms of their ratings of the children's anxiety and sleepiness symptoms, and to explore the relationship between parent- and child- rated anxiety (and child-rated fear of a balloon bursting) and response to the behavioural tasks. A one-way ANOVA (with time of sleep reduction as the independent variable, and parent and child reports of sleepiness as the dependent variables) was conducted to consider the effectiveness of the sleep reduction in terms of child and parent reports of sleepiness.

The primary aim of this study was to compare children's responses to the behavioural tasks when they had experienced a sleep reduction and when they had not, and this was assessed using a repeated measures ANOVA, with time of the sleep reduction as the independent variable, and responses to the behavioural tasks as the dependent variables. Correlational analyses were also conducted to explore the relationship between current and usual sleepiness (as rated by parents and children) and outcomes on the behavioural tasks. Finally, a one-way ANOVA (with time of sleep manipulation as the independent variable, and proportion closer the children stood to the balloon as the dependent variable) was conducted to consider a secondary question of the impact of the sleep reduction on the proportion closer to the balloon that children stood at Time 2 in comparison to Time 1. Although this study design was not ideal to address this secondary question, the data available was still useful to give some insight into the effect of reduced sleep on children's habituation behaviour.

### 6.4.2 Results

#### *6.4.2.1 Initial Analyses*

##### 6.4.2.1.1 Agreement between parent and child reports of anxiety and sleepiness

Moderate but non-significant positive correlations (based on commonly accepted criteria of .1 representing a small effect, .3 a moderate effect, and .5 a large effect, Field, 2005) were found between parent and child ratings of child anxiety, $r = .35$, $p = .20$. Similarly, small but non-significant positive correlations were found between parent and child ratings of current

sleepiness at Time 1, $r$ = .27, $p$ = .40. No significant correlations were found between parent and child ratings of usual sleepiness at Time 1 ($r$ = -.04, $p$ = .90), or between parent and child ratings of current sleepiness ($r$ = .12, $p$ = .72) or usual sleepiness ($r$ = .11, $p$ = .72) at Time 2. There was a significant positive correlation between Time 1 and Time 2 child-ratings of usual sleepiness, $r$ = .47, $p$ < .05. There were no other significant correlations between child or parent ratings of current or usual sleepiness, $p$ > .05.

#### 6.4.2.1.2 Associations between ratings of anxiety and sleepiness symptoms

There was a significant positive correlation between child-ratings of anxiety and usual sleepiness at Time 2 ($r$ = .45, $p$ < .05). Moderate but non-significant positive correlations were found between child-rated anxiety and child-rated current sleepiness at Time 1 ($r$ = .31, $p$ =.22), current sleepiness at Time 2 ($r$ = .33, $p$ = .23), and usual sleepiness at Time 1 ($r$ = .39, $p$ =.10), and between child-rated anxiety and parent-rated current sleepiness at Time 2 ($r$ = .41, $p$ = .13). Similarly, moderate but non-significant positive correlations were found between parent-rated anxiety and parent-rated usual sleepiness at Time 2 ($r$ = .37, $p$ = .17), and small but non-significant positive correlations were found between parent-rated anxiety and child-rated usual sleepiness at Time 2, $r$ = .27, $p$ = .34. There were no other correlations between parent ratings of anxiety and parent or child ratings of current or usual sleepiness.

#### 6.4.2.1.3 Anxiety and the behavioural tasks

There were no significant correlations between child or parent ratings of anxiety and the child's rating of fear of a balloon bursting, *ps* > .05. There were no significant correlations between child/parent ratings of anxiety and the outcomes on the behavioural tasks at either Time 1 or Time 2, or between child ratings of fear of a balloon being burst and the outcomes for the behavioural tasks, *ps* > .05.

#### 6.4.2.1.4 Sleepiness and the sleep reduction

Table 6.2 shows the mean scores for current and usual sleepiness at Time 1 and Time 2 according to parent and child ratings, and according to whether the child experienced the sleep

reduction at Time 1 or Time 2. A one-way ANOVA was conducted to check whether sleepiness scores (according to child- and parent-ratings) varied according to when the child experienced the sleep reduction or normal sleep. No significant differences in sleepiness was seen according to when the child had reduced or normal sleep, $p > .05$.

Table 6.2: Means and standard deviations of children's sleepiness scores at Time 1 and Time 2, according to whether they received the sleep reduction at Time 1 or Time 2

| | Time 1 Sleepiness Mean (SD) | Time 2 Sleepiness Mean (SD) |
|---|---|---|
| Current sleepiness (child rating) | | |
| Sleep reduction at Time 1 | 18.44 (6.02) | 18.25 (7.22) |
| Sleep reduction at Time 2 | 17.88 (6.66) | 14.43 (5.00) |
| Usual sleepiness (child rating) | | |
| Sleep reduction at Time 1 | 19.10 (4.28) | 17.45 (5.48) |
| Sleep reduction at Time 2 | 17.89 (4.28) | 15.44 (4.88) |
| Current sleepiness (parent rating) | | |
| Sleep reduction at Time 1 | 13.73 (5.87) | 7.90 (2.38) |
| Sleep reduction at Time 2 | 9.40 (5.50) | 9.60 (5.41) |
| Usual sleepiness (parent rating) | | |
| Sleep reduction at Time 1 | 9.18 (3.06) | 7.89 (2.26) |
| Sleep reduction at Time 2 | 9.80 (4.92) | 10.00 (4.18) |

#### 6.4.2.1.5 Sleepiness and the behavioural tasks

Correlational analyses were conducted to consider the effects of sleepiness on the children's responses to the behavioural tasks regardless of whether or not they had received the sleep reduction.

#### *6.4.2.1.5.1 Usual Sleepiness*

Negative, but mainly non-significant, correlations were found between parent reports of usual sleepiness at Time 1 and the distance task at Time 1 and Time 2, with more sleepy children standing closer to the balloon being burst. Similarly, a negative but non-significant correlation was found between parent-reports of usual sleepiness at Time 1 and the time the child took to burst the balloon at Time 2. No correlation was found between parent reports of usual sleepiness at Time 1 and the time taken to burst the balloon at Time 1 (see Table 6.3).

According to child reports, there was a positive, but non-significant, correlation between child reports of usual sleepiness at Time 1 and the distance and time tasks at Time 2, with more sleepy children standing further away from the balloon being burst and taking longer to burst the balloon compared to the less sleepy children. However, there were no significant correlations between children's ratings of usual sleepiness at Time 1 and responses to either the distance or time tasks at Time 1 (see Table 6.3).

#### *6.4.2.1.5.2 Current Sleepiness*

No significant correlations were found for parent or child ratings of current sleepiness at Time 1 and the children's responses to the behavioural tasks at Time 1 and Time 2 (see Table 6.3).

Table 6.3: Correlations between parent and child ratings of sleepiness at Time 1 and child responses to the behavioural tasks

| | Distance from balloon T1 (cm) | Distance from balloon T2 (cm) | Time to burst balloon T1 (secs) | Time to burst balloon T2 (secs) |
|---|---|---|---|---|
| Parent usual sleepiness | -.373 | -.547* | -.087 | -.226 |
| Parent current sleepiness | -.112 | .139 | -.116 | .173 |
| Child usual sleepiness | .194 | .405 | .066 | .419 |
| Child current sleepiness | .023 | .127 | -.101 | .055 |

*Note*: *$p < .05$

#### *6.4.2.2 Primary Question: How does reduced sleep affect outcomes on the behavioural tasks*

##### 6.4.2.2.1 Distance from the balloon

To consider the impact of the sleep reduction on the distance children stood from the balloon being burst, a repeated-measures ANOVA was conducted with Time of Sleep Reduction as the independent variable, and distance stood from the balloon following the sleep reduction and following a normal night's sleep as the repeated measures dependent variables. A main effect, that approached significance, was found for children's distance from the balloon according to whether they had experienced the sleep reduction or a normal night's sleep ($F(1, 17) = 4.13$, $p = .06$, $r = .44$), with children in the sleep reduction condition standing significantly closer to the balloon being burst compared with the children in the normal sleep condition (see Table 6.4 for means and standard deviations). There was no interaction of when the child received the sleep reduction (Time 1 or Time 2) on this main effect ($p > .05$), which suggests that this main effect was present regardless of whether children received the sleep reduction at Time 1 or Time 2.

Table 6.4: Means and standard deviations for the distance the child stood from the balloon at Time 1 and Time 2 (in cms) according to when children experienced the sleep reduction or normal sleep condition

| | Time 1<br>Mean (SD) | Time 2<br>Mean (SD) |
|---|---|---|
| Distance stood from the balloon (cms) | | |
| Sleep reduction condition | 135.90 (86.89) | 97.67 (144.41) |
| Normal sleep condition | 183.90 (134.59) | 117.11 (141.66) |

##### 6.4.2.2.2 Time to burst balloon

A repeated-measures ANOVA was conducted to consider the effect of reduced sleep on the time taken for children to burst the balloon, with Time of Sleep Reduction as the independent variable, and time taken to burst the balloon in the reduced sleep and normal sleep conditions as the repeated measures dependent variables. No main effect was found for whether the child had reduced or normal sleep on the time taken to burst the balloon ($F(1,17) = 0.285$, $p = .60$, $r$

= .13), and no interaction effect of Time of Sleep Reduction on these variables was found ($F(1,17) = 0.056$, $p = .82$, $r = .06$). See Table 6.5 for means and standard deviations.

Table 6.5: Means and standard deviations for the time taken to burst the balloon at Time 1 and Time 2 (in seconds) according to whether children experienced the reduced sleep or normal sleep condition

| | Time 1<br>Mean (SD) | Time 2<br>Mean (SD) |
|---|---|---|
| Time to burst balloon (seconds) | | |
| Sleep reduction condition | 7.73 (7.01) | 3.26 (2.69) |
| Normal sleep condition | 9.45 (8.84) | 3.93 (2.90) |

#### *6.4.2.3 Secondary Question: Does reduced sleep affect children's habituation to the distance task?*

The primary aim of Study 2 was to consider the effects of reduced sleep on children's avoidance behaviour during anxiety-provoking tasks. However, as a result of the finding in Study 1 that children habituated to the distance task from Time 1 to Time 2, Study 2 addresses a secondary question of whether reduced sleep affects children's habituation to this task. It should be noted that this study was not specifically designed to address this question, and is therefore not an ideal design, as only half of the children were rested at Time 2 (due to the counter-balancing of when children had reduced sleep, which was required for the primary question of this study).

To consider the effect of the sleep reduction on children's habituation to the task, a one-way ANOVA was conducted. As half of the sample had reduced sleep at Time 1, and half at Time 2, it was possible to consider the effects of the sleep reduction separately for children who received the sleep reduction at each time point. The means and standard deviations for distance stood from the balloon at Time 1 and Time 2 are, therefore, divided according to the time point that the child had reduced sleep (see Table 6.6). The results of the ANOVA revealed there to be a significant difference in the proportional change in distance according to whether children experienced reduced sleep at Time 1 or Time 2, $F(1, 17) = 5.35$, $p < .05$, $\omega^2 = .19$.

From consideration of the mean distance scores (see Figure 6.7), children who experienced reduced sleep at Time 1 stood further away from the balloon at Time 2 compared to their distance from the balloon at Time 1, although this difference did not reach significance, $t(18) = .45$, $p = .66$, $d = .21$. On the other hand, children who experienced reduced sleep at Time 2 stood closer to the balloon at Time 2 relative to their distance from the balloon being burst by the researcher at Time 1. Again, this difference did not reach significance, $t(18) = 1.47$, $p = .16$, $d = .69$.

Table 6.6: Means and standard deviations for the distance stood from the balloon task at Time 1 and Time 2 (in cms) according to the time point that children experienced reduced sleep

| | Time 1<br>Mean (SD) | Time 2<br>Mean (SD) |
|---|---|---|
| Distance stood from the balloon (cms) | | |
| Sleep reduction at Time 1 | 135.90 (86.89) | 187.45 (128.24) |
| Sleep reduction at Time 2 | 113.20 (134.14) | 97.67 (144.41) |

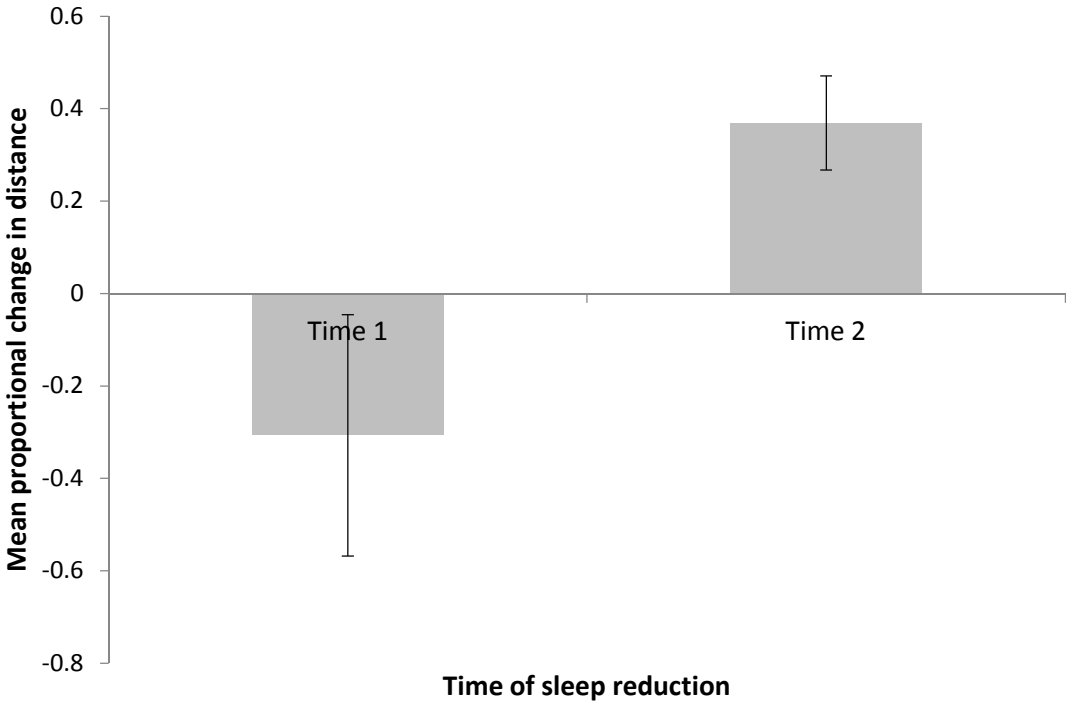


*Figure 6.7: Proportional change in distance stood from the balloon (cms) at Time 2 compared to Time 1 for children who experienced reduced sleep at Time 1 and at Time 2*

### 6.4.3 Study Two Discussion

In an extension of the data collected for Study 1, Study 2 considered parent reports of the children's sleepiness and anxiety symptoms (in addition to the children's reports). Small to moderate correlations were found between parent and child ratings of anxiety, and parent and child ratings of Time 1 current sleepiness, which suggests that there was reasonable agreement between parents and children about the child's symptoms. However, there was little agreement between parents and children in terms of their ratings of usual sleepiness at Time 1 and 2 and of current sleepiness at Time 2. As also found in Study 1, Study 2 found positive correlations between anxiety and sleepiness (both current and usual sleepiness) according to both parent and child ratings, with more sleepiness symptoms reported for children with greater anxiety symptoms.

However, most of the correlations found between parent and child ratings of anxiety and current sleepiness did not reach statistical significance. This is likely to have been due to the small sample size available in this study, and the subsequent lack of power. Although a larger sample size was vigorously sought, recruitment for this study was very difficult, with many parents reluctant to allow their children to engage in the sleep reduction or to come to the laboratory on two consecutive weeks. Recruitment was initially conducted through community groups, although, after little response using this method, recruitment was extended to sessions within the university laboratory, with parents given a small cash incentive to cover their travel costs. Although this method boosted recruitment to an extent, the final sample size still fell short of the number of participants needed to meet power requirements. Due to time constraints, it was necessary to close recruitment for this study and to work with the data available.

Interestingly, the sleep reduction was not found to be effective in inducing substantial reported sleepiness in the children. However, as can be seen from the mean sleepiness scores, there were small differences in the anticipated direction for both parent and child ratings of sleepiness according to when the child received the sleep reduction, and it is possible that the non-significance of this finding was due to power constraints. More specifically, mean sleepiness (current and usual) as rated by parents, and mean usual sleepiness as rated by children, was slightly higher at Time 1 for children experiencing the sleep reduction at Time 1 compared to sleepiness for the same children at Time 2 when these children did not experience the sleep reduction. This suggests that the sleep reduction did increase children's sleepiness slightly, although not to a statistically significant level. Interestingly though, there was little difference in parent-rated (and child-rated) sleepiness scores at Time 1 and Time 2 for children experiencing the sleep reduction at Time 2.

Mixed results were found for parent and child ratings of sleepiness and the outcomes on the behavioural tasks, regardless of when the children took part in the sleep reduction. Results based on parent-ratings of usual sleepiness suggest that the sleepier the children were, the closer

they stood to the balloon, and the less time they took to burst the balloon. These findings are counter to the hypotheses of the study. On the other hand, according to child-ratings of usual sleepiness, the opposite relationship was found, with sleepier children standing further away from the balloon being burst, and taking longer to burst the balloon compared to less sleepy children. Interestingly, current sleepiness (parent and child rated) was not significantly correlated with children's distance from the balloon or the time taken to burst the balloon. These findings suggest that current state of sleepiness does not affect children's avoidance behaviours on anxiety-provoking tasks, whereas usual, or trait, sleepiness might play a role in children's approach/avoidance behaviour. Further research is necessary to explore this relationship between sleepiness and avoidance behaviour.

Study 2 adopted a sleep reduction to consider the effects of reduced sleep on children's outcomes on the behavioural tasks. Reduced sleep was found to have an effect on children's response to the task, although interestingly, the hypothesis was not supported. Children who received the sleep reduction were found to show *more* confidence during the distance from the balloon task, with children who had experienced the sleep reduction (regardless of whether this was at Time 1 or Time 2) found to stand closer to the balloon being burst compared to when the children were in the normal sleep condition. However, no main effect was found for the sleep reduction on children's time taken to burst the balloon.

The secondary aim of Study 2 was to consider the effect of reduced sleep on children's habituation to the behavioural task where children chose how close to stand to a balloon being burst. This question arose from the results of the pilot study that indicated that children, in general, habituated to this task when presentations were a week apart. However, children were not found to habituate to the task in which they were timed while they burst a balloon, and so the same analyses were not conducted for this task. As mentioned above, this study was not designed to assess habituation to this task, but was instead designed to compare children's behaviours on the task when they had reduced sleep and when they had normal sleep. As such,

the order that children received the sleep reduction was counterbalanced so that any order effects could be accounted for, and therefore not all children were rested at the second time point. Thus, this is not an ideal design to test the effect of reduced sleep on children's habituation to the task. On the other hand, it was possible to conduct some preliminary explorations of this effect. Nonetheless, the results need to be interpreted with caution due to this limitation in study design.

Children's habituation to the task was found to differ according to whether they received the sleep reduction at Time 1 or Time 2. The children who experienced the sleep reduction at Time 1 were not found to habituate to the task, but actually showed greater fear by standing further away when repeating the task a week later. On the other hand, children who didn't receive the sleep reduction until Time 2 were found to habituate to the task at Time 2 in comparison to where they stood at Time 1. This may suggest that reduced sleep at the first exposure to an anxiety-provoking stimulus has more of a negative effect on children's behavioural outcomes towards later exposures to an anxiety-provoking stimulus compared to having a normal sleep at that first exposure. Although it was not a significant difference, children who had reduced sleep did stand slightly further away than the children who were rested. It is likely that the non-significant difference is due to lack of power.

Therefore, although further research is required to explore these results, the slight difference in distance scores may suggest that sleep reduction impairs children's processing of initial exposures to frightening stimuli. This explanation fits well with other research evidence from the adult literature, which suggests that sleep deprivation (compared to normal sleep) during a memory encoding phase was associated with greater susceptibility to forming false memories (Frenda et al., 2014). Likewise, in the current study, children who had reduced sleep prior to their first exposure to the task may have been less able to accurately process their experience of the task, which may have led to greater fear (in terms of greater avoidance) the following week. On the other hand, children who were well rested for their first exposure to the

task may have been better able to process their experience, and were therefore not so negatively affected for their second exposure, regardless of the fact that they had reduced sleep on this occasion. Unfortunately though, it was not possible to directly compare the children who received the sleep reduction to those who had normal sleep, as the two groups were not equivalent at Time 2 (as some had received the sleep reduction at Time 2). It would be useful to explore this further using a randomised controlled trial (RCT) design where an additional group receives normal sleep the night before both the first and second testing sessions.

For Study 3, a decision was made to remove the behavioural task where children's time taken to burst the balloon was measured, since no main effects were found for this task. In addition, response to this task was stable over time and, therefore, not suitable for assessing children's habituation. Instead, Study 3 focuses on the distance that children stood from the balloon, so that the effect of sleepiness on children's habituation towards the task could be explored using a larger sample.

## 6.5 Study 3

Having determined from Studies 1 and 2 that sleepiness may affect children's habituation towards an anxiety-provoking stimulus when tested *a week apart*, Study 3 explored these findings further through considering children's habituation to the behavioural task when the exposure points occurred on the *same day*. Due to time and resource constraints, it was not possible to implement a sleep reduction for this study.

### 6.5.1 Method

#### *6.5.1.1 Power*

67 children were required for a power of 80% to detect a medium effect size of 0.3, assuming an alpha of .05. According to these criteria and based on the sample of 96 children recruited for this study, a power of 91% was achieved.

#### *6.5.1.2 Participants*

Participants included 96 children (61.5% female) from school years 3-6 who were recruited from five schools in the South-East of England. The age range of children was 7 to 11 years, with a mean age of 9.11 years (SD = 1.17). This age range was chosen for similarity with previous studies in this field. The inclusion criteria for this study were that the children attended one of the recruited schools at the time of testing, were in school years 3-6, spoke at least moderately good English, and were able to commit to the two testing sessions. Children with a moderate to severe developmental disorder were excluded from the study, as determined by their parents at the time of consent.

#### *6.5.1.3 Measures*

**Child Sleepiness Scale**: Adapted from the Pediatric Daytime Sleepiness Questionnaire (Drake et al., 2003) as described for Study 1.

**Multidimensional Anxiety Scale for Children – 10 (MASC-10) -** J. March et al. (1997)**:** As described for Study 1.

**Fear of balloons bursting (self-report):** As described for Study 2.

#### *6.5.1.4 Procedure*

Ethical approval and recruitment of schools and children were repeated as for Study 1. Testing for Study 3 was conducted at two time points, approximately 3-4 hours apart. At Time 1 (the morning session), children gave written consent prior to completing the questionnaires in small groups within school. Children then individually participated in a behavioural task, which involved asking the child to choose how close to stand while a balloon was burst by the researcher. Distance from the balloon was measured. As in Studies 1 and 2, balloon size was standardised using a gauge to ensure consistency. At Time 2 (in the afternoon), the behavioural task was repeated.

#### *6.5.1.5 Data Analysis*

Initial analyses were conducted to explore the relationship between anxiety and sleepiness, and between anxiety and responses on the behavioural task across the two time points. Correlational analyses were conducted between current and usual sleepiness and outcomes on the behavioural task for Time 1 and Time 2 data. Correlational analyses were then conducted to consider the relationship between current or usual sleepiness and habituation to the task (that is, the proportion closer to the balloon that children stood at Time 2, compared to Time 1).

### 6.5.2 Results

#### *6.5.2.1 Cross-sectional associations between anxiety, sleepiness, and the behavioural task*

There was a small and significant positive relationship between children's anxiety and '*usual sleepiness*' score ($r = .22$, $p < .05$), with greater symptoms of sleepiness reported for children with more anxiety symptoms. However, there was no significant relationship between children's anxiety and their '*current sleepiness*' score, $r = .18$, $p = .09$. There was no significant correlation between children's anxiety score and the distance that they stood from the balloon at Time 1 ($r = .12$, $p = .23$) or at Time 2 ($r = .16$, $p = .13$). However, there was a significant correlation between children's ratings of how scared they were of a balloon being burst and the distance that they stood from the balloon at Time 1 ($r = .30$, $p < .01$), with greater distance from the balloon found for children who were more scared of it being burst. No correlation was found between how scared the children were of a balloon being burst and their distances from the balloon at Time 2 ($r = -.17$, $p = .10$).

#### *6.5.2.2 Association between sleepiness and responses to the behavioural task*

There was no significant correlation between current or usual sleepiness and the distance the child stood from the balloon at Time 1 (current: $r = .07$, $p = .53$; usual: $r = .09$, $p = .43$) or at Time 2 (current: $r = -.08$, $p = .47$; usual: $r = -.11$, $p = .29$).

Mean distance from the balloon reduced significantly from Time 1 (mean = 185.76 cm; SD = 142.72) to Time 2 (mean = 98.31 cm; SD = 107.33), suggesting that, in general, children habituated to the task, $t(93) = 7.61$, $p < .001$, $d = 1.58$. Further correlational analyses were,

therefore, conducted to consider the relationship between current and usual sleepiness and the proportion that children stood closer to the balloon at Time 2 compared with Time 1. As in Studies 1 and 2, the proportional change score was calculated by subtracting the distance score at Time 2 from the distance score at Time 1, then dividing the result by the distance score at Time 1, and multiplying by 100%.

#### 6.5.2.2.1 Current Sleepiness

Significant positive correlations were found between current sleepiness and the proportional change in distance ($r = .24$, $p < .05$), with the sleepier children found to have a greater proportional change in distance from Time 1 to Time 2; that is, the more sleepy the children were, the closer they stood to the balloon being burst at Time 2 compared to where they stood at Time 1 (see Figure 6.8).

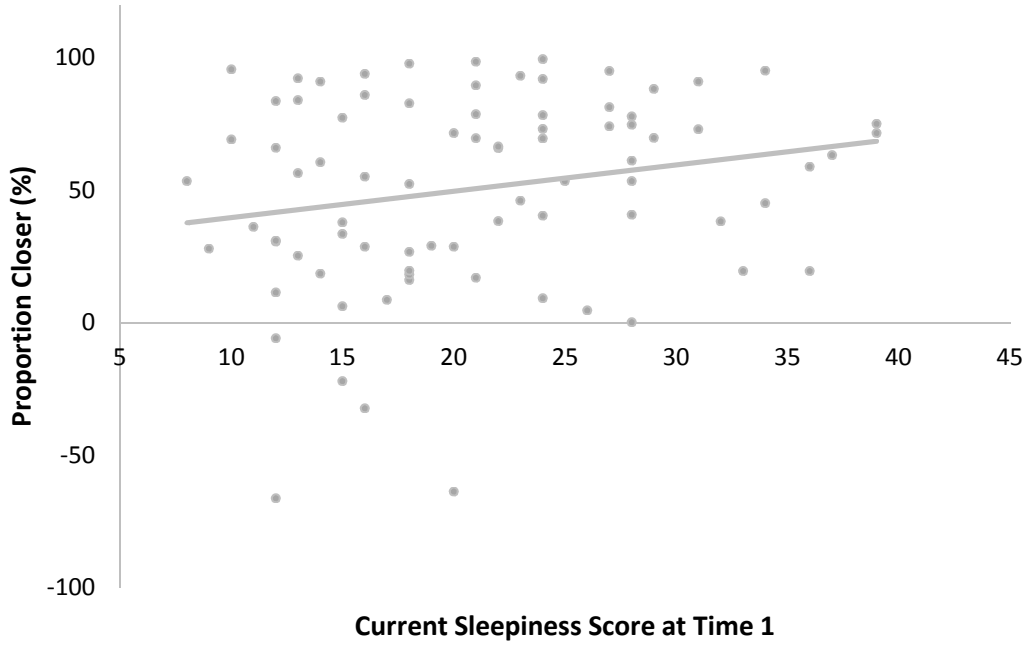


*Figure 6.8: The relationship between current sleepiness score and the proportion closer that the child stood to the balloon being burst by the researcher at Time 2 in comparison to Time 1*

#### 6.5.2.2.2 Usual Sleepiness

As for current sleepiness scores, significant positive correlations were found between usual sleepiness and the proportional change in distance ($r = .24$, $p < .05$), with the sleepier children found to stand closer to the balloon being burst at Time 2 compared to where they stood at Time 1 (see Figure 6.9).

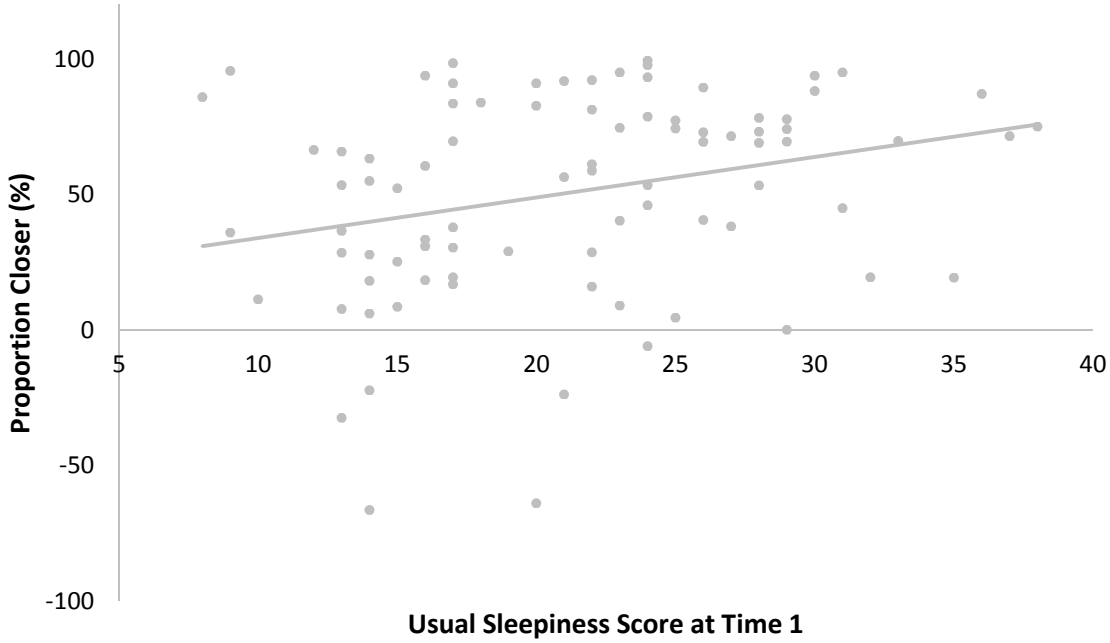


*Figure 6.9: The relationship between usual sleepiness score and the proportion closer that the child stood to the balloon being burst by the researcher at Time 2 in comparison to Time 1.*

### 6.5.3 Study 3 Discussion

As in Studies 1 and 2, the results from Study 3 showed a significant positive correlation between self-reported child anxiety and ratings of usual sleepiness. However, no significant correlations were found between self-reported anxiety and *current* sleepiness (as also found in Study 2), which may suggest that the association between anxiety and sleepiness is only present for children who have more frequent difficulties with sleepiness. Anxiety symptoms were not found to be correlated with responses to the behavioural task in this study. However, this may be because the measure of anxiety symptoms (MASC-10) does not specifically assess children's fear of balloons bursting, and so this finding may suggest that children scoring higher in anxiety

symptoms did not necessarily feel anxious about balloons being burst. On the other hand, there was a significant correlation between children's rating of how scared they were of a balloon being burst and the distance that the children stood from the balloon at Time 1, with more scared children standing at a greater distance from the balloon. This finding offers some support for the validity of the behavioural task used in this study, since children who were more anxious about the task demonstrated more avoidance of the stimulus (in terms of distance stood from the stimulus during the task).

Children's sleepiness was not significantly correlated with children's initial distances stood from the balloon at Time 1, or with their distances from the balloon at Time 2. Mean distance that children were willing to stand from the anxiety-provoking stimulus reduced from Time 1 to Time 2, as in the previous two studies. It was, therefore, possible to consider the effect of children's sleepiness on their habituation towards the task. The positive correlation between children's sleepiness (current and usual) and the proportion that children stood closer to the balloon at Time 2 (compared to where they stood at Time 1) suggested that, counter to the hypothesis and the findings of Studies 1 and 2, more sleepiness was associated with greater habituation to the task, as indicated by a greater proportional reduction in the distance that the children stood from the balloon at Time 2 compared with Time 1. This finding may, therefore, suggest that children's sleepiness, both current and usual, was beneficial to the child when facing an anxiety-provoking situation for a second time within the same day (as opposed to a week apart as in Studies 1 and 2).

## 6.6 General Discussion

Results from each of the studies suggest that, as for previous findings of *sleep problems* being associated with childhood anxiety (for example, Alfano et al., 2006; Alfano, Ginsburg, & Newman Kingery, 2007), child ratings of *usual sleepiness* were associated with their symptoms of anxiety. Study 2 similarly found that parent-ratings of usual sleepiness were associated with the child's anxiety symptoms. However, only Study 1 found a significant positive association

between child-ratings of *current sleepiness* and anxiety symptoms, although Study 2 found small but non-significant positive correlations between these variables. The results of Study 3 did not suggest that current ratings of sleepiness were associated with the children's ratings of their anxiety symptoms. These findings may suggest that an association between anxiety and sleepiness is only present when children have frequent difficulties with sleepiness, and may not be dependent on children's current state of sleepiness.

The aim of the current paper was to consider the impact of child sleepiness and reduced sleep on children's behavioural outcomes (in terms of avoidance and habituation) when presented with an anxiety-provoking stimulus. Mixed results were found in response to this research question across the studies (see Table 6.7 for a summary of the findings). While Studies 1 and 2 found that increased sleepiness was associated with poorer habituation towards the anxiety-provoking stimuli, Study 3 found the opposite effect. Indeed, the outcomes for sleepy children when given same-day repeated exposures to the stimuli (Study 3) were better than for the less sleepy children, with greater habituation to the task found for the children reporting greater sleepiness. One explanation for these differing results is that while Studies 1 and 2 adopted a repeated measures design with approximately *one week* between the testing points, Study 3 adopted a repeated measures design with approximately *3-4 hours* between the testing points. It is possible that sleepiness does not negatively affect children's behavioural outcomes when re-approaching an anxiety-provoking stimulus when exposed to it within the same day. On the other hand, when given a week between exposures to the stimuli, results from Studies 1 and 2 suggest that worse habituation was found for the children reporting greater sleepiness and for children who had reduced sleep the night before their first exposure to the stimulus.

Table 6.7: Summary of findings across the three studies

| | Study 1 | Study 2 | Study 3 |
|---|---|---|---|
| Time between | 1 week | 1 week | 3-4 hours |

| | | | |
|---|---|---|---|
| exposures | | | |
| Raters | Child only | Child and Parent | Child only |
| Current sleepiness and distance from the balloon | Time 1: Greater sleepiness = closer<br>Time 2: No associations | No associations | No associations |
| Usual sleepiness and distance from the balloon | Time 1: No associations<br>Time 2: Greater sleepiness = further away | Child-ratings Time 1: no associations<br>Child-ratings Time 2: Greater sleepiness = further away<br>Parent-ratings Time 1: Greater sleepiness = closer<br>Parent-ratings Time 2: Greater sleepiness = closer | No associations |
| Direction of change in distance scores | Greater sleepiness = further away | Sleep reduction at Time 1 = Further away<br>Sleep reduction at Time 2 = Closer | Greater sleepiness = Closer |

However, the design of Study 2 was not ideal for testing children's habituation to the task, as not all children were rested at Time 2. It would be helpful to conduct further research using an RCT design to explore the effect of reduced sleep on children's habituation, with one

group experiencing the sleep reduction at Time 1, while a control group has normal sleep, and both groups repeating the tasks in a rested state one week later.

Children's sleep between the exposures to the stimuli may have played a role in the difference in findings for children's habituation to the task across the studies. Indeed, previous research has shown that memories are reactivated during sleep, which leads to the consolidation of long-term memories (Born & Wilhelm, 2012). The findings from Studies 1 and 2 may, therefore, suggest that the children processed their exposure to the anxiety-provoking situation during their sleep the night after the first exposure, and consolidated their memory of that event and any fears that they experienced during the event. On the other hand, when the exposures occurred within the same day in Study 3, the children did not have the opportunity to sleep prior to the second exposure, and due to returning to class between the sessions, they also did not have any time to process their experience prior to their second exposure. However, it is not clear from these findings why sleep between the exposures would lead to poorer habituation a week later, or why sleepier children who had no opportunity to process their experience of the first exposure would benefit for their second exposure by showing greater habituation to the task compared to the less sleepy children. These results clearly require replication and further exploration. In addition, the results from Study 2, in which children had reduced sleep either the night before the first exposure or the second exposure, suggest that these findings may be explained by children's sleepiness at the time of being exposed to the behavioural task, rather than children's ability to process the events during sleep after the exposures. Further research could also consider the effect of reduced sleep the night *after* exposure to explore whether this also plays a role.

Results from the sleep reduction analyses in Study 2 suggest that children who received the sleep reduction were less avoidant in their approach towards the stimulus the day after the sleep reduction. That is, the children were found to stand closer to the balloon being burst following a sleep reduction the night before, compared to when the children had a normal

night's sleep, regardless of the order in which children were in the sleep reduction or normal sleep conditions. This finding may suggest that children who have reduced sleep are less bothered by the anxiety provoking stimuli, which is also supported by the findings of Study 1 in that the children with greater current sleepiness were found to stand closer to the balloon being burst at Time 1. However, the opposite results were found for children's avoidance/approach behaviour according to child-rated usual sleepiness scores in Studies 1 and 2, with children who reported greater sleepiness at Time 2 found to stand further away from the balloon at Time 2. Study 3, on the other hand, did not find any significant correlations between children's sleepiness and the distances that they stood from the balloon.

Overall, there appears to be a trend for increased sleepiness at the first exposure to be associated with greater approach behaviour, while greater sleepiness at the second exposure may be associated with greater avoidance behaviour. However, given the lack of significant correlations between sleepiness and distance found for Study 3, further research is required to explore these relationships before any firm conclusions can be drawn.

## 6.7 Conclusion

The studies presented in this paper appear to suggest that children's sleepiness or reduced sleep may interfere with children's ability to approach anxiety-provoking stimuli, with the results suggesting that increased sleepiness may interfere with children's processing of exposures to the anxiety-provoking stimuli. For instance, a trend was found across the studies reported in this paper of greater sleepiness at the first exposure being associated with more approach behaviour, while greater sleepiness at the second exposure was associated with more avoidance behaviour. In addition, having a longer period between exposures appeared to negatively affect the sleepier children's habituation to the task, whereas having repeated exposures on the same day appeared to benefit sleepier children in terms of greater habituation. This finding may suggest that, for anxious children who are sleepy, it is more effective for exposures to the feared stimuli to occur in one day, such as in One-Session Treatment (Ollendick et al., 2009; Öst et al., 2001).

However, much more research is required to replicate the findings of this study, and to explore this further, before any firm conclusions can be drawn.

# Chapter 7: Paper 6 - The relationship between sleep problems and outcomes of a child anxiety intervention

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## 7.1 Abstract

There are clear associations between sleep problems and anxiety in children. The current study considered the relationships between anxiety and sleep problems in the context of a parenting-based anxiety intervention. Families of children aged 2-9 diagnosed with an anxiety disorder were randomised to a parenting-based cognitive-behavioural intervention or to a wait-list control group. Sleep problem and anxiety symptom data were analysed at pre-intervention, post-intervention and follow-up. There was no significantly greater reduction in sleep problem scores for children in the intervention group compared to the control group. Pre-intervention sleep problems did not predict anxiety symptom outcomes at post-intervention or at follow-up, and post-intervention sleep problems did not predict anxiety symptom outcomes at follow-up. In addition, improvement in sleep problems from pre- to post-intervention was not associated with improvement in anxiety symptoms from post-intervention to follow-up. These findings suggest that sleep problems do not negatively affect children's outcomes following a parent-delivered cognitive-behavioural intervention for childhood anxiety. Explanations for these findings are explored.

## 7.2 Introduction

A growing body of research considering the associations between sleep problems and anxiety has developed over recent years. However, although there is increasing evidence of an association between sleep problems and anxiety using adult samples (for example, Fuller, Waters, Binks, & Anderson, 1997; Ramsawh, Stein, Belik, Jacobi, & Sareen, 2009; D. Taylor, Lichstein, Durrence, Reidel, & Bush, 2005), there remain limited studies considering this association in children. Of the research evidence available, strong associations have been found between sleep problems and anxiety in children, with 83% of parents of anxious children reporting at least one intermittent child sleep complaint, 46% reporting at least one frequent child sleep complaint, and 66% reporting two or more child sleep complaints (Alfano et al., 2006). In addition, anxious children exhibit more awakenings, less slow-wave sleep (Forbes et

al., 2008), greater bedtime resistance, more sleep anxiety (Hansen et al., 2011) and greater sleep latency (Forbes et al., 2008; Hansen et al., 2011) than non-anxious children. However, these results are not found consistently. For instance, Hudson et al. (2009) did not find increased sleep latency for anxious children compared with non-anxious children, but concluded that this could be explained by their finding that anxious children go to bed later and have less sleep than non-anxious children. It is also unclear whether or not children with anxiety disorders experience daytime sleepiness as a result of their disrupted sleep. Some researchers have found that children with anxiety disorders have greater daytime sleepiness (Calhoun et al., 2011; Hansen et al., 2011) whereas others did not find greater daytime sleepiness in anxious children (Hudson et al., 2009).

Sleep problems and anxiety have a bidirectional relationship in both adults and children, with authors from a number of studies suggesting that sleep problems predict later anxiety symptoms (Jansen et al., 2011; Neckelmann, Mykletun, & Dahl, 2007) whereas others suggest that anxiety precedes the development of sleep problems (Calhoun et al., 2011; Forbes et al., 2008; Johnson, Roth, & Breslau, 2006). For instance, sleep problems such as dyssomnia, parasomnia, short-sleep duration and having no set bedtime have been found to be associated with later anxiety (Jansen et al., 2011). On the other hand, Forbes et al. (2008) suggest that anxiety interferes with young peoples' sleep, and that longer sleep latency and awakenings may be attributed to the anxious youths' lack of a sense of safety. To investigate the bi-directionality of sleep problems and anxiety, Cousins et al. (2011) used models to predict night time sleep from daytime affect and vice versa. They found that as negative affect increased during the day, those with anxiety disorders had an increase in the time spent awake the following night, whereas those who had increased positive affect during the day had a decrease in the time spent awake the following night. In addition, night time sleep predicted youths' daytime affect the following day. Increased time spent awake predicted more negative affect the following day for anxious youth, and more time spent asleep was related to increased positive affect the following day (Cousins et al., 2011).

Evidence for the association between sleep problems and anxiety highlights the need to investigate whether one problem affects the other in relation to treatment. Similarly, a recent review highlights the gap in literature for research considering the mediating effect of sleep problems on anxious children's treatment outcomes (Cowie et al., 2014). The current study explored changes in sleep problems following a cognitive-behavioural parenting intervention for childhood anxiety disorders, as well as the impact of sleep problems on children's anxiety symptoms throughout the treatment period.

### 7.2.1 Treatment of anxiety and sleep problems

Anxiety treatment research in children has predominantly focused on cognitive behavioural therapy (CBT) which is widely accepted as beneficial in reducing anxiety symptoms (for example, Liber et al., 2010; Muris, Meesters, & van Melick, 2002). Until recently, there was no research considering the use of CBT for children with anxiety disorders aged 6 years and under. However, CBT-based interventions for childhood anxiety have now been found to be beneficial for this younger age group (Hirshfeld-Becker et al., 2010; Waters, Ford, Wharton, & Cobham, 2009), with parent interventions found to be useful for younger children, instead of directly including the children in the interventions (Cartwright-Hatton et al., 2011; Waters et al., 2009).

Behavioural therapies are also commonly implemented for the treatment of sleep problems, and have been shown to be effective (Didden, Curfs, van Driel, & de Moor, 2002; Mindell, Kuhn, Lewin, Meltzer, & Sadeh, 2006; Robinson & Richdale, 2004), with significant changes noted within a few days (Meltzer, 2010). As with the behavioural element of CBT for child anxiety, behavioural therapy for sleep disorders uses techniques of consistent positive reinforcement for positive behaviours, ignoring negative behaviours, and giving the child an element of control (Meltzer, 2010). In their review of behavioural therapies for sleep problems, Mindell et al. (2006) found that 94% of the studies reported significant reductions in bedtime resistance and night time waking following the behavioural interventions, which was maintained up to six months later.

### 7.2.2 Current Study

Although studies investigating the treatment of sleep problems have looked at treatment within the context of comorbities such as developmental difficulties (Didden et al., 2002; Robinson & Richdale, 2004), there is a lack of research considering the impact of sleep problems on the treatment of anxiety disorders in children, and in considering the effect of an anxiety intervention on children's comorbid sleep problems. Taking into account the associations found between sleep problems and anxiety, and the similarities in the therapies adopted for the treatment of these problems, this is surprising. The current paper aimed to address this gap in literature through studying the effect of a cognitive-behavioural, parenting-based anxiety intervention on the reported sleep problems of anxious young children. In addition, the current study aimed to explore the impact of sleep problems on children's anxiety symptoms across the period of the intervention.

The hypotheses for the current study were as follows:

1) Following the intervention/wait-list period and at 12 month follow-up, there would be a significantly greater reduction in sleep problem scores for children in the anxiety intervention group compared to children in the control group.
2)
    a. Pre- intervention sleep problem scores would predict post-intervention and follow-up anxiety symptom scores
    b. Post-intervention sleep problem scores would predict follow-up anxiety symptom scores
    c. Improvement in sleep problems from pre- to post-intervention would be associated with improvement in anxiety symptoms from post-intervention to follow-up

## 7.3 Method

### 7.3.1 Power

To achieve 80% power to detect a medium effect size ($f^2$) of 0.15, and assuming an alpha of .05, a total of 68 children were required for this study. Based on the 74 children recruited for this study, 84% power was achieved according to these criteria.

### 7.3.2 Participants

The data used in this study were initially reported by Cartwright-Hatton et al. (2011). Participants included 74 children (57% female) aged 2.7 to 9 years (mean = 6.6 years) with anxiety disorders, and their parent/carer with a mean age of 35 years. Parents/carers identified the ethnicity of the majority of children as 'white' (n = 55), one child as 'Pakistani', and eight children as 'other'. Ethnicity data was not provided for the remaining ten children. Families were referred from Mental Health Services (n = 10), or were self-referred (n = 64). Children were initially screened using the internalising scale of the Child Behaviour Checklist. Further screening using the Anxiety Disorders Interview Schedule (ADIS) was then conducted with those who met or exceeded the clinical cut-off on the internalising scale of the Child Behaviour Checklist, or were considered likely to have an anxiety disorder according to their preliminary interview with a clinical psychologist. Families were excluded from the study if the parent or child had moderate-to-severe learning difficulties or if the child had moderate-to-severe autistic spectrum disorder. Families with other comorbid disorders such as oppositional defiant disorder or depression were not excluded. Participant primary diagnoses at trial entry included specific phobia (*n* = 30), social anxiety disorder (*n* = 19), generalised anxiety disorder (*n* = 11), separation anxiety disorder (*n* = 5), obsessive compulsive disorder (*n* = 2), posttraumatic stress disorder (*n* = 1), panic disorder (*n* = 1), or no diagnosis (*n* = 4).

### 7.3.3 Measures

**Child Behaviour Checklist (parent version) (CBCL) -** Achenbach and Rescola (2000, 2001)

Two versions of this measure were implemented according to the children's age: the CBCL for children aged 1.5 to 5.11 years and the CBCL for children aged 6 to 18 years. For the purpose of the current study, only the 'sleep problems' subscale was used, which consists of 7 items

(such as, “sleeps less than most children”, and “has trouble going to sleep”). Previous studies have also used this subscale as a measure of sleep problems (for example, Alfano et al., 2007; Alfano et al., 2009; Gregory & O’Connor, 2002). The internal consistency of the sleep problems scale was acceptable for the scale used for the younger age group, and was low for the scale used with older age group (1.5 to 5 years, $\alpha = 0.87$; 6 to 18 years, $\alpha = 0.56$). Gregory and O’Connor (2002) similarly found low internal consistency for this scale. They suggested that the low alpha is likely due to some items on the scale reflecting opposite sleep problems, and so children would not score on both of the items (for example ‘sleeping more than most children’ versus ‘sleeping less than most children’), but concluded that this scale was sufficient for assessing general rather than specific sleep problems.

**Screen for Child Anxiety Related Disorders (parent version) (SCARED) –** Birmaher et al. (1997)

Parents reported their child’s anxiety symptoms across 41 statements rated on a 3-point scale. The SCARED measure has good internal consistency across the five subscales ($\alpha = .74$ to .93), good test-retest reliability (intraclass correlation coefficient (ICC) = .70 to .90), and shows good discriminative validity (Birmaher et al., 1997). Although designed for use with children aged eight years and over, no parent-report measures of anxiety for children younger than age eight were identified and so a decision was made to use this scale.

**Anxiety Disorder Interview Schedule (parent version) (ADIS) -** Silverman and Albano (1996)

Childhood DSM-IV anxiety disorders were assessed at pre-intervention using the parent version of the ADIS interview, with diagnoses assigned if parents reported significant interference (rated 4+ on a scale of 0-8). Inter-rater agreement was 96.6% based on a random sample of 20% of the interviews. Please note, this measure was used to assess the eligibility of participants for this study, and further analyses were not conducted using the ADIS for this paper.

### 7.3.4 Intervention

The two main goals of the intervention were to *'enable parents to provide their children with a warm, calm, predictable home environment, in which gentle, positive discipline was used to manage difficult behaviour and to encourage confident behaviour'* and to *'help parents manage children's anxiety using cognitive-behavioural skills'* (Cartwright-Hatton et al., 2011, p. 245). The intervention consisted of 10 group sessions for parents, each lasting approximately two hours. Children were not included in these group sessions. The sessions included an introductory session (covering topics such as the role of parental attention in childhood behaviour, causes of anxiety, an introduction to CBT, and general tips on routines), child-centred play, anxiety education, praise and fear hierarchies, rewards, limit setting, planned ignoring of minor negative behaviours, managing worry, using consequences and time out with an anxious child, and a general round-up session (including revision, relapse prevention, and celebration). Sleep was not addressed within the intervention. For more information about the content of these sessions, please refer to Cartwright-Hatton et al. (2011).

### 7.3.5 Procedure

Children were initially screened using the parent-report CBCL, and those who met the clinical cut-off for internalising symptoms were invited for an intake diagnostic interview (the ADIS) to assess their eligibility for participation against the inclusion and exclusion criteria. Consent was taken at this stage. Families were randomised to the intervention or a wait-list control using telephone randomisation (with concealed allocation) conducted by an independent agency, and parents were asked to complete the questionnaires about their child. Parents of children in the intervention group attended 10 group sessions of a new cognitive-behavioural intervention. The children received no direct intervention. After completing the intervention (or 10-week wait-list period), parents completed the post-test questionnaires about their child, and completed the

follow-up questionnaire 12 months later. For more information about randomisation procedures, please refer to Cartwright-Hatton et al. (2011).

## 7.4 Results

### 7.4.1 Anxiety intervention and sleep problems scores

To address Hypothesis 1, a 3 (Time: pre-intervention; post-intervention; follow-up) X 2 (Condition: CBT intervention; wait-list control) mixed ANOVA was conducted to investigate whether there was a greater reduction in sleep problem scores for children in the intervention group compared to children in the control group. Results from the two versions of the CBCL (age 1.5 to 5.11 years; age 6 to 18 years) were combined, as suggested by the manual, to maximise the sample size for analysis.

Pre-intervention, post-intervention, and follow-up data were available for 53 children. Twenty-eight of these received the intervention, while 25 were in the wait-list control group. Mauchley's test of sphericity was violated (.86, $p < .05$) so Greenhouse-Geisser statistics are reported. There was a main effect of time, with a significant change in sleep problem scores over time, irrespective of condition, $F(1.76, 88.01) = 14.49$, $p < .001$. Helmert planned contrasts revealed that there was a significant reduction in sleep problems from pre-intervention to post-intervention and follow-up ($F(1, 50) = 23.33$, $p < .001$, $r = .56$), but that there was no significant reduction in sleep problems from post-intervention to follow-up, $F(1, 50) = 1.78$, $p = .19$, $r = .17$. However, the time x condition interaction was non-significant ($F(1.76, 90.03) = 1.09$, $p > .05$, r = .11), suggesting that any significant change in sleep problem scores across time was not associated with the condition that participants were in (see Table 7.1).

Table 7.1: Mean sleep scores pre- anxiety intervention, post- anxiety intervention and at 12-month follow-up

| | Mean | SD | N |
|---|---|---|---|
| Pre-intervention | | | |

| | | | |
|---|---|---|---|
| Intervention | 3.79 | 3.51 | 28 |
| Control | 4.52 | 3.90 | 25 |
| Post-intervention | | | |
| Intervention | 2.07 | 2.91 | 28 |
| Control | 3.72 | 3.23 | 25 |
| 12 month follow-up | | | |
| Intervention | 1.71 | 2.68 | 28 |
| Control | 3.08 | 3.05 | 25 |

### 7.4.2 Relationship between pre-intervention sleep problems and anxiety scores at post-intervention and follow-up

To explore whether sleep problems at pre-intervention predicted anxiety symptoms at post-intervention (to address the first part of Hypothesis 2a), a multiple regression analysis was conducted. Pre-intervention anxiety scores were entered in the first step of the model, and pre-intervention sleep scores entered in the second step of the model. As this analysis was intended to consider the effect of sleep problems on the anxiety outcomes of children following the intervention, only data for those randomised to the intervention group was used for this analysis. Both Steps 1 and 2 significantly predicted post-intervention anxiety scores, Step 1: $F(1, 30) = 30.24$, $p < .001$, r = .71; Step 2: $F(2,30) = 15.27$, $p < .001$, r = .72. However, Step 2, where pre-intervention sleep problem scores were added to the model, was not found to significantly increase the amount of variability in post-treatment anxiety symptoms, $\Delta R^2 = .01$, p > .05 (see Table 7.2).

Table 7.2: Multiple regression model exploring pre-intervention sleep and anxiety scores as predictors of anxiety scores at post-intervention

| | b | SE B | β |
|---|---|---|---|
| Step 1 | | | |

| | | | |
|---|---|---|---|
| Constant | -.536 | 3.967 | |
| Pre-intervention anxiety | .636 | .116 | .714* |
| Step 2 | | | |
| Constant | -.334 | 3.998 | |
| Pre-intervention anxiety | .580 | .135 | .652* |
| Pre-intervention sleep | .414 | .512 | .123 |

*Note*. $R^2$ = .51 for Step 1; $\Delta R^2$ for Step 2 = .01; *$p$ < .001

A similar multiple regression analysis was conducted to explore whether pre-intervention sleep problems predicted anxiety symptoms at follow-up (to address the second part of Hypothesis 2a). As for the previous analysis, pre-intervention anxiety symptom scores were entered into the first step, and pre-intervention sleep problem scores were entered into the second step. Both Steps 1 and 2 significantly predicted anxiety symptoms at follow-up, Step 1: $F(1, 30) = 9.65$, $p < .01$, r = .50; Step 2: $F(2, 30) = 5.82$, $p < .01$, r = .54. Step 2, where pre-intervention sleep problem scores were added to the model, did not significantly increase the amount of variance in anxiety scores at follow-up accounted for by the model, $\Delta R^2 = .04$, $p > .05$ (see Table 7.3).

Table 7.3: Multiple regression model exploring pre-intervention sleep and anxiety scores as predictors of anxiety scores at follow-up

| | b | SE B | β |
|---|---|---|---|
| Step 1 | | | |
| Constant | -.370 | 6.245 | |
| Pre-intervention anxiety | .566 | .182 | .500* |
| Step 2 | | | |

| | | | |
|---|---|---|---|
| Constant | -.879 | 6.179 | |
| Pre-intervention anxiety | .706 | .209 | .624* |
| Pre-intervention sleep | -1.042 | .791 | -.243 |

*Note*. $R^2$ = .25 for Step 1; $\Delta R^2$ for Step 2 = .04; * $p$ < .01

### 7.4.3 Relationship between post-intervention sleep problems and anxiety scores at follow-up

To address hypothesis 2b, a multiple regression analysis was conducted to explore the effect of post-intervention sleep problems on children's anxiety symptoms at follow-up. Children's post-intervention anxiety scores were entered into Step 1 of the regression model, and post-intervention sleep problem scores were entered into Step 2 of the model. Both steps significantly predicted children's anxiety symptoms at follow-up, Step 1: $F(1, 30) = 22.24$, $p < .001$, r = .66; Step 2: $F(2, 30) = 10.92$, $p < .001$, r = .66. However, Step 2, where post-intervention sleep problems were added to the model, did not significantly increase the amount of variance in follow-up anxiety symptom scores accounted for by the model, $\Delta R^2 = .00$, $p > .05$ (see Table 7.4).

Table 7.4: Multiple regression model exploring post-intervention sleep and anxiety scores as predictors of anxiety scores at follow-up

| | b | SE B | β |
|---|---|---|---|
| Step 1 | | | |
| Constant | 1.117 | 4.057 | |
| Post-intervention anxiety | .838 | .178 | .659* |
| Step 2 | | | |

| | | | |
|---|---|---|---|
| Constant | .732 | 4.197 | |
| Post-intervention anxiety | .907 | .234 | .713* |
| Post-intervention sleep | -.467 | 1.014 | -.085 |

*Note*. $R^2$ = .43 for Step 1; $\Delta R^2$ for Step 2 = .00; * $p < .01$

### 7.4.4 Improvement in sleep problems and anxiety symptoms

To address Hypothesis 2c, that is, whether an improvement in sleep problems was associated with an improvement in anxiety symptoms, a correlational analysis was conducted using proportional change scores from pre- to post-intervention for sleep problems, and from post-intervention to follow-up for anxiety symptoms. Proportional change scores for sleep problems were calculated by subtracting post-intervention sleep problem scores from pre-intervention sleep problem scores, and dividing the result by pre-intervention sleep problem scores. Likewise, proportional change scores for anxiety symptoms were calculated by subtracting follow-up anxiety symptom scores from post-intervention anxiety symptom scores, and dividing the result by post-intervention anxiety symptom scores. The results of the correlational analysis did not indicate any significant relationship between improvement in sleep problems from pre- to post-intervention and improvement in anxiety symptoms from post-intervention to follow-up, $r$ = -.04, $p > .05$.

## 7.5 Discussion and Conclusions

This study attempted to address an important gap in research regarding sleep problems and anxiety disorders. Previous literature does not appear to have investigated whether an intervention for sleep problems or anxiety in children has an effect on the other problem, nor has it considered the relationship between sleep problems and anxiety symptoms in the context of an anxiety intervention for children. Indeed, this gap in literature has also been identified in a recent review of sleep and anxiety literature (Cowie et al., 2014).

The findings of the current study suggest that, although sleep problems were found to reduce across the period of the intervention, children in the anxiety intervention did not have a significantly greater reduction in sleep problems compared to those in the wait-list control group. This may suggest that sleep problems improve, to a degree, with the passage of time. It is worthy of note that the CBT adopted in the current study did not specifically target sleep problems, and so future research could consider whether anxiety interventions which additionally address anxiety-related sleep problems are effective in reducing both anxiety and sleep problems. It is interesting that CBT interventions for child anxiety disorders do not currently address comorbid sleep problems, particularly in consideration of the strong associations between the two (for example, Alfano et al., 2006).

A number of explanations are possible with regard to the non-significant difference in the reduction of sleep problems between the CBT intervention and the wait-list control groups. Firstly, it is possible that CBT interventions designed for treating anxious children are not additionally beneficial for treating the child's sleep problems. However, it is difficult to accept this conclusion, considering previous findings of the bidirectional nature of anxiety and sleep problems. If an increase in anxiety has been demonstrated to lead to more sleep problems (Calhoun et al., 2011; Cousins et al., 2011; Forbes et al., 2008; Johnson et al., 2006) and an increase in sleep problems to lead to greater anxiety (Cousins et al., 2011; Jansen et al., 2011; Neckelmann et al., 2007), then it is plausible that a reduction in anxiety would also reduce sleep problems, and vice versa. Indeed, findings from the adult literature have found CBT interventions for generalised anxiety disorder (GAD) to additionally improve insomnia symptoms even though, as in the current study, sleep problems were not addressed within the intervention (Bélanger, Morin, Langlois, & Ladouceur, 2004). The discrepancy in findings between the current study and Bélanger et al.'s (2004) study could be due to the difference in diagnoses across the two samples. For instance, while Bélanger et al. (2004) specifically used a sample of adults with GAD and assessed symptoms of insomnia, the current study used a sample of children with various anxiety disorder diagnoses and assessed a range of sleep

problems. Therefore, it is possible that the anxiety intervention used by Bélanger et al. (2004) specifically improves insomnia symptoms, but not sleep problems in general. On the other hand, the discrepancy in results may reflect differences in the temporal stability of sleep problems in children and adults. Results from the current study suggested that children's sleep problems reduced across time, regardless of whether or not they received the intervention. This finding is consistent with other research findings that children's sleep problems generally improve alongside the child's development over time (K. Davis et al., 2004; Simola et al., 2012), and suggests that the anxiety intervention played no role in this improvement. On the other hand, sleep problems in adults may be less transient without an intervention, and the results from Bélanger et al. (2004) suggest that an anxiety intervention may be sufficient in additionally reducing symptoms of insomnia.

An alternative explanation for the non-significant reduction in sleep problems following the anxiety intervention is that the current study used data from children ranging in age from 2.7 to 9 years, which meant that two versions of the CBCL were used to measure sleep problem scores (one version for children under the age of 6 years, and another for children aged 6 years and over). There were slight differences in the sleep items used in each of these versions, and it is possible that this had an impact on the findings. However, the differences between these were minimal and so this is an unlikely explanation. Secondly, the CBCL was not designed specifically as a measure of sleep problems. The items included in this measure were, therefore, not as extensive as alternative measures designed specifically to capture children's sleep problems, such as the Child Sleep Habits Questionnaire (CSHQ, Owens et al., 2000). Indeed, the CBCL uses only 7 items to capture information about children's sleep problems, compared to 33 items on the CSHQ, and only captures whether children have difficulties in sleeping, sleep more or less than other children, have nightmares, and have difficulties with bed-wetting and sleep talking/walking (Achenbach & Rescola, 2001). Interestingly, although the CBCL for younger children also captures whether children show resistance to going to bed, not wanting to sleep alone, and awakenings during the night (Achenbach & Rescola, 2000), these same

questions are not asked for children from the age of 6, yet these are likely to be a problem for some children in this older age group as well. In addition, the CBCL does not capture information about other sleep behaviour problems, such as restlessness during sleep, snoring, rocking or rhythmic moving, co-sleeping, inconsistencies in length of sleep time, or difficulties in waking up in the morning. Despite these issues with the CBCL for assessing children's sleep problems, other studies have successfully used this measure for assessing sleep problems (e.g. Alfano et al., 2007, 2009; Gregory & O'Connor, 2002; Johnson et al., 2000), and since the CBCL has been widely used and validated as a measure, it was deemed appropriate for use in the current study.

The sample used in this study also requires consideration. The data used in the current study were originally collected for Cartwright-Hatton et al.'s (2011) randomised controlled trial for a new parenting-based CBT intervention for anxiety in younger children. Prior to their study, few studies had investigated the efficacy of a CBT intervention that included children under the age of 6. Although they found the intervention to be effective in reducing anxiety symptoms and diagnoses for this age group, it is possible that these younger children may not have found the CBT intervention beneficial in reducing sleep problems. Due to small sample sizes in the different age groups for the current study, it was not possible to conduct this analysis using just children aged over 6 years, yet it is possible that CBT for anxiety disorders in older children may have an effect on associated sleep problems, which warrants further investigation. In addition, the current study used data from a CBT intervention delivered to parents without their children present. Findings from Cartwright-Hatton et al.'s study (2011) suggest that this type of intervention is effective in significantly increasing the likelihood of children being free from their anxiety disorder diagnosis. However, it is possible that an intervention that involves the children may have more of a positive effect on the children's sleep problems. Further research could also investigate whether an intervention for sleep problems has a positive effect on children's anxiety problems.

The three parts of the second hypothesis explored whether children's sleep problems affected children's anxiety symptom outcomes following the intervention. Interestingly, the hypotheses of this study were not supported. Pre-intervention sleep problems were not found to predict children's anxiety symptoms at either post-intervention or follow-up; nor were post-intervention sleep problems found to predict children's anxiety symptoms at follow-up. In addition, there were no significant correlations between improvement in sleep problems and improvement in anxiety symptoms from pre- to post-intervention.

These non-significant findings may suggest that children's comorbid sleep problems do not have a negative impact on children's outcomes following a cognitive-behavioural intervention. However, it is possible that the reduction in sleep problems that was noted across the period of the study (regardless of whether children were in the intervention group or the wait-list control), may have played a role in this. These results suggest that children's sleep problems were not stable. Therefore, the non-significant results for the impact of sleep problems on anxiety symptom outcomes may reflect the fact that sleep problems at pre-intervention were reportedly more intense than at post-intervention, and the reduction in sleep problem scores prior to post-intervention testing may have reduced the effect of pre-intervention sleep problems on anxiety outcomes at post-treatment. On the other hand, the non-significant correlation between improvement in sleep problems and improvement in anxiety symptoms suggests that reductions in sleep problems may not be directly associated with improvements in anxiety symptoms.

However, although there was a significant reduction in sleep problems over time, this was not something that was directly targeted within the intervention. It would, therefore, be interesting for future research to consider whether an intervention that does target sleep problems in anxious children would be additionally beneficial for children in terms of the reduction of anxiety symptoms.

In conclusion, the current research addresses an important gap in literature with regards to whether interventions for child anxiety disorders also have an effect on child sleep problems, and in considering the relationship between sleep problem and anxiety variables throughout a treatment programme. The current study did not find a significant difference in sleep problems following the intervention between those in the intervention group and those in the wait-list control. However, the data for the current study was based on a specific type of intervention – namely a parent-based CBT intervention for children aged 2.7 - 9 years. As discussed, a number of factors may have moderated the outcomes of this study and so further research is warranted to investigate whether an anxiety intervention can improve sleep problems in anxious children. In addition, sleep problems were not found to affect children's outcomes following the anxiety intervention, although it would be interesting for further research to consider the impact of sleep problems on children's intervention outcomes for anxiety disorders when there is a substantial reduction in comorbid sleep problems.

# Chapter 8: Thesis Discussion

## 8.1 Discussion

Although it is widely accepted that sleep problems are associated with childhood anxiety (Alfano et al., 2006, 2007; Chase & Pincus, 2011), there is little research that considers *how* children's sleep problems affect their anxiety. In addition, there appears to be no research exploring the association between children's current state of *sleepiness* (as opposed to trait *sleep problems*) and anxiety, or exploring the relationship between sleepiness and the processes associated with childhood anxiety, yet there is also a substantial body of research which suggests that adequate sleep is important for optimum cognitive functioning (for example, Astill et al., 2012; Beebe et al., 2010; Berger et al., 2012; Kopasz et al., 2010; Sadeh et al., 2003). The aim of this thesis, therefore, was to address these gaps in literature by exploring the relationship between children's current state of sleepiness and childhood anxiety, as well as by exploring the relationship between both current state of sleepiness and trait sleep problems and the processes associated with childhood anxiety.

It is surprising that interventions for childhood anxiety do not currently address comorbid sleep problems, particularly given that it is plausible that these untreated sleep problems may interfere with the efficacy of the interventions. Another aim of this thesis was to consider the role of sleepiness and sleep problems within the context of cognitive-behavioural interventions for childhood anxiety disorders.

### 8.1.1 State sleepiness and childhood anxiety

According to results from Papers 3 and 4, while sleep *problems* were associated with children's anxiety symptoms according to parent ratings, children's *sleepiness* was not found to be associated with children's anxiety symptoms. These findings may suggest that, unlike trait or frequently occurring sleep problems, states of sleepiness simply are not associated with children's anxiety symptoms. However, the vast majority of children tested in these studies did not report high levels of sleepiness, and so these non-significant results may reflect the limited variance in sleepiness scores across the samples. To address this issue, Paper 5 introduced a

sleep reduction manipulation in an attempt to create more variance in children's sleepiness scores. However, even in the pilot study in which no sleep reduction was used, significant correlations were found between children's reports of both usual and current states of sleepiness with symptoms of anxiety. In addition, similar results were found in the study that implemented the sleep reduction to manipulate children's sleepiness. Therefore, like *sleep problems,* these studies provide some evidence for the association of state *sleepiness* with childhood anxiety symptoms. However, most of the associations between sleepiness and anxiety found in the studies in this paper were for *usual* states of sleepiness, with only one of the studies finding an association between *current* state of sleepiness and anxiety. It is possible, therefore, that the relationship between sleepiness and anxiety may only be present when children suffer from frequent sleepiness, which may be a symptom of sleep *problems,* rather than when children are in a current state of sleepiness. However, sleep problems were not assessed in Paper 5, which meant that further analyses could not be conducted to consider whether usual states of sleepiness still correlated with anxiety after controlling for associations between sleep *problems* and anxiety. Given the mixed findings across these papers, further research is required.

### 8.1.2 Sleep problems, sleepiness and anxiety processes

This thesis included a series of studies considering the role of sleepiness and sleep problems on processes involved in childhood anxiety. Specifically, this thesis considered the effect of sleepiness and sleep problems on cognitive processes of ambiguity resolution (Paper 3) and emotion recognition (Paper 4), and on behavioural processes of avoidance and habituation (Paper 5). While previous research suggests that there are associations between *sleep problems* and anxiety, no research (to the authors' knowledge) has considered the role of sleep problems or sleepiness on specific processes of childhood anxiety.

As no significant associations were found between *sleepiness* and childhood anxiety for the papers exploring cognitive processes, it was not possible to address the question of whether ambiguity resolution and emotion recognition processes mediated the relationship between

sleepiness and anxiety. However, there was limited variance in children's sleepiness in these studies, which may explain why no association was found. On the other hand, associations were found between children's *sleep problems* and anxiety symptoms, which meant that analyses could be conducted to explore whether these cognitive processes mediated the association between sleep problems and anxiety.

Surprisingly, no mediation effects were found for ambiguity resolution (Paper 3) or for emotion recognition processes (Paper 4). However, these cognitive processes were also not found to be associated with the children's symptoms of anxiety, and, therefore, these non-significant results may be reflective of sampling issues for these studies. For instance, although both studies used a sample of children 'at-risk' of developing an anxiety disorder (because their parent was clinically anxious), in addition to a community sample of children, there was still limited variability in children's anxiety symptom scores, with most children scoring relatively low on anxiety symptoms. Therefore, the non-significant mediation effects for these cognitive processes may simply be a reflection of an insufficient range of anxiety symptoms across the sample.

The studies included in Paper 5 addressed these sampling limitations by including a sleep reduction manipulation (in which children went to bed two hours later than their usual bedtime) to consider the role of sleepiness on children's behavioural processes during anxiety-provoking situations. Findings from the pilot study of Paper 5 suggested that one of the behavioural tasks, the time taken for the child to burst a balloon, was a suitable measure since it was resistant to practice effects, and was associated with children's self-reports of anxiety symptoms. Although the other behavioural task (the distance children stood from the balloon being burst) was also associated with children's anxiety symptoms, it was not resistant to practice effects and was therefore less suitable as a measure for this question. However, this task did present the opportunity to consider the effect of sleepiness on children's habituation towards the task, which led to the development of a third study to explore this effect further.

While the results of the studies in Paper 5 were mixed for the effect of sleepiness on children's avoidance behaviour, there did appear to be a trend for sleepy children *not* to avoid the anxiety-provoking stimuli, but instead to stand closer to the stimuli for their initial exposure to it. This finding was counter to that hypothesised. However, these relationships between sleepiness and the behavioural tasks were generally only found for *usual* sleepiness scores, rather than for children's *current* states of sleepiness scores. This may suggest that children's current states of sleepiness do not affect children's avoidance behaviours, whereas usual, or more trait-like, symptoms of sleepiness may help children to show increased approach behaviour towards anxiety-provoking stimuli. Based on the research evidence that a reduction in sleep across a few consecutive nights negatively affects children's cognitive functioning (Beebe et al., 2010; Sadeh et al., 2003; Vriend et al., 2013), a potential explanation for this unexpected finding could be that the children who were more usually sleepy did not have the cognitive resources to respond to their feelings of anxiety and avoid the anxiety-provoking stimuli.

Mixed results were also found for the effect of children's sleepiness on their habituation towards the anxiety-provoking task. Studies 1 and 2 of Paper 5 suggested that more sleepy children were less effective at habituating to the behavioural task, whereas Study 3 of Paper 5 suggested that sleepy children were more effective at habituating to the task. However, this difference in findings is likely to be due to the differences in study design. While Studies 1 and 2 had the two testing sessions approximately *one week* apart, Study 3 conducted both testing sessions within the same day with just a *few hours* between the testing sessions. This meant that children in Study 3 were not given the opportunity to process their initial exposure to the stimuli prior to their second exposure (particularly as they returned to class between testing sessions), unlike the children in Studies 1 and 2 who had a week to process their experiences.

### 8.1.3 Sleep problems, sleepiness and the treatment of childhood anxiety

This thesis began with a meta-analysis considering the efficacy of transdiagnostic CBT for the treatment of childhood anxiety disorders. The aim of this paper was to consider how effective

this mode of treatment delivery was across the spectrum of childhood anxiety disorders, which was a question that had not previously been addressed. As the remainder of the papers in this thesis considered sleep problems, sleepiness and anxiety within the context of CBT interventions, this seemed an appropriate introduction to the thesis. The findings of this meta-analysis suggested that transdiagnostic CBT was an efficacious mode of treatment delivery for childhood anxiety disorders, with children who completed the full treatment found to be nine times more likely to remit from their anxiety diagnosis compared to children who completed a wait-list period. Based on the conservative intent-to-treat analysis, children who received transdiagnostic CBT were almost four times more likely to remit from their diagnosis compared to those in the wait-list condition. Interestingly, similar findings were found regardless of whether children received individual or group treatment, suggesting that both formats were equally effective.

Chapter 7 explored the relationship between sleep problems and anxiety in the context of an anxiety intervention, and considered whether the treatment of children's anxiety was also beneficial in reducing the children's comorbid sleep problems, whether sleep problem scores would predict children's anxiety outcomes, and whether improvements in sleep problems were associated with improvements in anxiety symptoms (Paper 6). The results of this study did not suggest that the anxiety intervention was additionally effective in reducing children's sleep problems, nor did sleep problems predict children's anxiety symptom outcomes following the intervention. Similarly, there was no relationship between children's improvement in sleep problem scores and improvement in anxiety symptoms. It is, therefore, possible that children's sleep problems do not affect children's outcomes following CBT for anxiety disorders.

However, it is possible that these non-significant results were due to the treatment delivery method used in this study not being based on a standard protocol of CBT. This paper used data available from a previous study (Cartwright-Hatton et al., 2011) to consider these secondary questions. The primary aim of the original study was to consider the efficacy of

parent-delivered CBT in an attempt to treat younger children unable to engage in traditional CBT delivery, rather than directly include the children within the treatment. It is possible, therefore, that different results would have been found had a more traditional treatment approach been used. Due to time and resource constraints, it was not possible to implement an RCT using a more traditional approach of CBT to consider the effect of sleep problems on anxious children's treatment outcomes. Instead, this thesis made use of an available dataset to conduct exploratory analyses of this effect. Further research using an RCT is, therefore, required to further explore whether sleep problems (and sleepiness) affects children's outcomes on a traditionally-delivered transdiagnostic CBT intervention for childhood anxiety disorders, and similarly, whether an intervention for children's sleep problems has a positive effect on children's anxiety symptoms.

In addition, it would be useful to conduct further research in this area using a more standardised measure of children's sleep problems, such as the Children's Sleep Habits Questionnaire (Owens et al., 2000). Although the sleep subscale of the CBCL was considered appropriate for use in this study, this measure was not designed specifically to assess children's sleep problems and may not have been the ideal measure to use. For instance, the CBCL is not as extensive as alternative measures, using only seven items to consider children's sleep problems, with inconsistent items used in the measure for children under and over 6 years old. While the measure for the under 6 year olds includes questions about children's bedtime resistance, not wanting to sleep alone, and night awakenings (Achenbach & Rescola, 2000), the same questions are not included on the measure for children over 6 years old (Achenbach & Rescola, 2001). Other sleep problems, such as restlessness during sleep, snoring, rocking during sleep, co-sleeping, inconsistent time asleep, and waking difficulties, are also not included in the CBCL.

Paper 2 of this thesis explored the role of sleepiness on children's learning and unlearning of fears through vicarious learning, with their parents acting as models. Although

sleep problems and sleepiness were not found to affect children's fear beliefs about the stimuli and reaction times to approach the stimuli following vicarious experiences, *sleep problems* (but not *sleepiness*) were found to interact with children's heart rates following negative and positive vicarious experiences of their parents interacting with the stimuli. That is, the higher children's sleep problem scores, the more their heart rates increased in the experimental conditions, suggesting that children's sleep problems may play an important role in the acquisition of fears through the vicarious learning pathway. However, children's heart rates did not reduce significantly from the negative vicarious learning condition to the positive vicarious learning condition, regardless of their sleep problems scores. As such, there was insufficient variance in heart rate scores for the two experimental conditions to consider the effect of children's sleep problems or sleepiness on the reduction of anxiety based on positive vicarious learning experiences. However other studies have found positive vicarious learning to reduce children's anxiety (for example, Kelly et al., 2010). It is, therefore, possible that the non-significant reduction in anxiety following the positive vicarious experience may be due to methodological limitations. For instance, video observations were used to provide the vicarious learning experience, rather than direct observations, and it is possible that this limited the positive cues that children observed during the positive vicarious experience.

Further research is, therefore, required to consider the role of sleep problems and sleepiness on the unlearning of fear in successful positive vicarious learning situations. This may be achievable through children directly observing their parents approach the stimuli, rather than watching a video of their parents' approach. In addition, although child sleepiness was considered in this study, there was an insufficient range of scores of sleepiness, with most children not reporting high levels of sleepiness. It is possible that the non-significant results found for the effect of children's sleepiness on the learning and unlearning of fear in this study could be accounted for by the lack of variance in sleepiness scores. Further research is required to investigate the role of sleepiness in the vicarious learning and unlearning of fears, using a sample of children with a wider distribution of sleepiness scores.

### 8.1.4 Limitations and directions for future research

Although the papers in this thesis attempt to address the question of the role of sleep problems and sleepiness in cognitive and behavioural processes of childhood anxiety, a number of limitations may have resulted in the inconclusive findings. For instance, the studies exploring cognitive processes were run in parallel, using the same sample of children who took part in both studies on the same day. Although this was not anticipated to be a limitation of the studies at the time, there was, unfortunately, an insufficient range of sleepiness scores and anxiety scores across the sample. In particular, it was anticipated that an adequate range of anxiety scores would be achieved, as half of the sample were children of clinically anxious parents and were classified as 'at-risk' of developing anxiety themselves. However, despite this, there was still insufficient variance in children's anxiety scores, which is likely to account for the non-significant findings for these studies. Further research could consider whether these cognitive processes mediate the relationship between sleep problems/sleepiness and anxiety using a sample of clinically anxious, rather than at-risk children, along with a community sample of children. In addition, given the strong associations between childhood anxiety and sleep problems (for example, Alfano et al., 2007), it is likely that by including clinically anxious children, the sample would also represent more diversity in children's sleep problems scores.

There are also a number of issues concerning the measurement of sleep problems and sleepiness in children. For instance, parents' reports of their children's symptoms rely on their knowledge about the children's symptoms, and it is likely that this knowledge may be biased according to whether parents perceive their children's symptoms to be problematic (Werner, Molinari, Guyer, & Jenni, 2008), or parents could simply be unaware of sleep problems affecting their child (Gregory et al., 2011). Likewise, child self-reports are likely to be limited. For instance, it was observed that children were reluctant to admit to suffering from sleepiness due to concerns about this resulting in an earlier bedtime. On the other hand, Gregory et al. (2011) highlight research findings that children from non-clinical samples appear to report *more* sleep problems, compared to reports from their parents. These issues raise the question of when

children can accurately report on their own symptoms of sleepiness. For the studies included in this thesis, children were asked to report on their symptoms of sleepiness from the age of 5 (using a pictorial scale) and from the age of 7 (using a questionnaire measure). Although the manual of the original Pediatric Daytime Sleepiness Scale (Drake et al., 2003) states that the questionnaire should be suitable for children from 5 years of age, the measure has actually only been validated from the age of 11 years. Therefore, reliance on parent-reports and child self-reports may be limited, and it may have been beneficial to additionally include actigraphy, polysomnography or sleep diary data.

On the other hand, a benefit of using questionnaire data is that children's sleep problems could be captured over a greater period of time (about 6 months), whereas actigraphy or polysomnography data tends to only reflect sleeping patterns for about a week, and may not reflect typical sleeping patterns. In addition, questionnaire data has been shown to correlate with these objective measures (Gregory et al., 2011), suggesting that the questionnaire data is useful to assess children's enduring sleep problems. For instance, the item "overtired" was correlated with fewer arousals according to polysomnography, the item "sleeps less than other children" was correlated with less sleep duration and fewer arousals according to polysomnography, the item "trouble sleeping" was associated with less time asleep according to polysomnography, and the item "sleeps more than other children" was correlated with shorter sleep latency according to actigraphy (Gregory et al., 2011). These findings, therefore, give some credence to the use of parent-report questionnaires in the assessment of children's sleep problems. However, it is acknowledged that future research in this area would benefit from the additional use of actigraphy or polysomnography to capture a more objective measure of children's sleep problems, as well as the use of sleep diaries. However, although there are alternative objective measures of children's *sleep problems* that could have been used, to the author's knowledge, there are currently no alternative objective measures of children's *sleepiness*.

To address the issues of insufficient variance in children's sleepiness scores and of there being no objective measure of children's sleepiness, further research could consider the effect of a sleep manipulation, which increases children's sleepiness, on children's anxiety-related cognitive processes, or could use a sample of children who are seeking help for sleep problems. Although a sleep manipulation was used in one study to address these issues, this study was subject to other limitations. In particular, recruitment was much more challenging than anticipated and the required sample size was not achieved, despite vigorous attempts at boosting recruitment. As such, further research is required, using a larger sample of children who engage in the sleep reduction manipulation. In addition, the initial aim of this study did not include addressing the question of habituation. However, this question was raised following analysis of the pilot data. Therefore, the study design of the sleep reduction study was not ideal for testing children's habituation to the task, as not all children were rested at the second testing session. Further research using an RCT design would be useful to consider the effects of the sleep reduction condition on children's habituation to the task, compared with a control group who did not receive a sleep reduction manipulation prior to either testing session.

Additional research could consider the effects of the sleep reduction the night *after* exposure to the anxiety-provoking stimuli, rather than manipulating children's sleep *prior* to the exposure, as was done in the study reported here. As the behavioural responses to same-day repeated exposures were so different from the week-apart exposures, it is possible that this is associated with children's processing of the exposure. Manipulating children's sleep the night after the exposure may help to explain this difference. Indeed, Frenda et al. (2014) found that sleep deprivation in adults following the encoding of memories was associated with an increased susceptibility to forming false memories. Likewise, it is possible that a sleep manipulation following an exposure to anxiety-provoking stimuli may interfere with children's processing of that exposure.

There also remains a need for further research to explore the effect of sleep problems and sleepiness on children's outcomes following treatment for anxiety disorders. Given that almost 90% of children with anxiety disorders also suffer from at least one comorbid sleep problem (Alfano et al., 2007), it seems surprising that sleep problems are not addressed within anxiety interventions as standard. In addition, it is surprising that there appears to be no research to date which considers the effect that children's comorbid sleep problems may have on anxious children's treatment outcomes. However, a recent review of the literature does identify that this is an area that has so far been neglected (Cowie et al., 2014), which suggests the need for more research in this area is beginning to be recognised.

## 8.2 Conclusions

This thesis addresses an important gap in the literature exploring the role of sleep problems and sleepiness in childhood anxiety. Although the findings in this thesis do provide some preliminary evidence for the role of sleep problems and sleepiness in children's anxiety processes and treatments, the findings are inconclusive and there is a need for further research to clarify these results and to draw some firm conclusions. However, it is hoped that the initial explorations of these research questions will act as a useful guide for further research in this area.

Drawing on the preliminary findings for this area of research, there appears to have been a trend for sleepiness to be associated with poorer outcomes in terms of habituation towards anxiety-provoking stimuli. On the other hand, there appears to have been a trend for sleepiness to be associated with better initial approach, rather than avoidance, towards these stimuli. There was no evidence for anxiety-related cognitive processes mediating the relationship between children's sleep problems and anxiety symptoms, although this may have arisen because of a lack of variance in anxiety scores for children. Negative results were found for the role of sleep problems and sleepiness in the treatment of childhood anxiety. Although the studies do not provide evidence for the role of sleep problems and sleepiness in the treatment of

childhood anxiety, these studies suffer from a number of unavoidable limitations, which may explain these non-significant findings. Given the strong associations between sleep problems and anxiety, it seems plausible that sleep problems and sleepiness will play an influential role in the treatment of childhood anxiety. It is, therefore, important for this area to be explored further, as this could hold important clinical implications for the treatment of childhood anxiety disorders.

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# Appendices

# Appendix 1 – References for meta-analysis studies

## A1.1 Included Studies


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## Appendix 2: Details of studies included in the meta-analysis

| Study details | Therapy type | Comparison condition | Outcome measure | Exclusion criteria | Outcome |
|---|---|---|---|---|---|
| Cobham (2012), Australia<br>Sample : GAD , SAD, SoP, SP, AP, PD, PTSD<br>Age : 7-14 years | FCBT - 6 parent sessions, 90 minutes; 6 child sessions, 60 minutes<br>Bibliotherapy (BT) | Wait-list control | ADIS | If children were currently involved in an alternative treatment for anxiety (whether psychological or pharmacological), if they had a psychotic disorder, or significant intellectual disability. | FCBT > WL<br>BT > WL<br>FCBT = BT |
| Spence et al. (2011), Australia<br>Sample: GAD, SoP, SAD, SP<br>Age: 12-18 years | CBT; Internet CBT - 10 child sessions, 60 minutes;<br>5 parent sessions, 60 minutes | Wait-list control | ADIS | Primary diagnosis of panic disorder, OCD, PTSD, participants with a moderately disturbing mood disturbance, with a pervasive developmental disorder, learning disorder, significant behavioural disorder, substance abuse, suicidal ideation, or current self-harm. | GCBT > WL<br>Internet CBT > WL<br>GCBT = Internet CBT |

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| Hirshfeld-Becker et al. (2010), USA<br>Sample: SAD, SoP; GAD, AP, SP<br>Age: 4-7 years | FCBT - 20 sessions over 6 months | Wait-list control (6 months) | K-SADS | Active psychosis, suicidality or substance abuse in a parent; mental retardation in the child; current psychiatric treatment or past CBT; too uncooperative/ distractible, too severely symptomatic to wait 6 months for treatment, severe social isolation, severe impairment in school function/ attendance, or severe OCD | FCBT > WL |
| W. Lau, Chan, Li, and Au (2010), Hong Kong<br>Sample: GAD, SAD, SoP<br>Age: 6-11 years | GCBT - 9 sessions; 2 hours | Wait-list control | K-SADS | Specific phobias, severe hyperactivity not managed by medication | GCBT > WL |
| March, Spence, and Donovan (2009), | Internet-based CBT - 10 weekly sessions, 1 hour | Wait-list control | ADIS | Non-clinical levels of anxiety, presence of a developmental disorder or learning disability, presence | CBT > WL |

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| Australia<br>Sample: SAD, GAD, SoP, SP<br>Age: 7-12 years | (Child)<br>6 weekly sessions, 1 hour (parent) | | | of primary depressive disorder, involvement in other psychiatric treatment, presence of primary behavioural disorders, lack of access to computer, failure to complete screening assessment; presence of OCD, panic disorder or PTSD | |
| Waters, Ford, Wharton, and Cobham (2009), Australia<br>Sample: SP, SoP, GAD, SAD<br>Age: 4-8 years | GCBT-P; GCBT-PC - 10 weekly sessions, 60 minutes | Wait-list control | ADIS | Comorbid externalising disorder, pervasive developmental disorder, organic brain damage, psychosis, currently involved in psychological or pharmacological treatment for anxiety disorders | GCBT > WL<br>GCBT-PC > WL<br>GCBT-PC = GCBT |
| Bodden et al. (2008), Netherlands<br>Sample: SoP, | CCBT; FCBT - 13 sessions, 60-90 minutes | Wait-list control | ADIS | OCD, PTSD, substance abuse, current suicide attempts, psychoses, autistic-spectrum disorder, untreated ADHD, IQ under 80, use of anxiety-reducing | CCBT + FCBT > WL<br>CCBT > |

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| SAD, GAD, SP, PD<br>Age: 8-18 years | | | | medication | FCBT (ST)<br>CCBT =<br>FCBT (LT) |
| Walkup et al. (2008), USA<br>Sample: GAD, SoP, SAD<br>Age: 7-17 years | CBT; Sertraline; Combination of CBT + sertraline - 14 child sessions, 60 minutes | Placebo | ADIS | An unstable medical condition, refusal to attend school due to anxiety, or no response to two adequate trials of SSRIs or an adequate trial of CBT, pregnant girls, children receiving psychoactive medications, psychiatric diagnoses (i.e., current major depressive or substance- use disorder; type ADHD; or a lifetime history of bipolar, psychotic, or pervasive developmental disorders) or those who presented an acute risk to themselves or others | CBT > PBO<br>CBT+S > PBO<br>S > PBO<br>CBT+S > CBT<br>CBT+S > S<br>CBT = S |

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| Rapee, Abbott, and Lyneham (2006), Australia<br>Sample: GAD, SoP, SAD, SP, OCD, PD<br>Age: 6-12 | GCBT-PC - 9 parent and child sessions, 120 minutes<br>Bibliotherapy (BT) | Wait-list control | ADIS | Children with comorbid nonanxiety disorders (unless these disorders demanded immediate attention, e.g. severe school non-attendance, suicidal risk). Children on medication were included if the medication had been stable for the previous month | GCBT > BT > WL |
| Spence, Holmes, March, and Lipp (2006), Australia<br>Sample: SAD, GAD, SoP, SP<br>Age: 7-14 years | GCBT; Internet CBT - 10 child sessions; 6 parent group sessions, 60 minutes | Wait-list control | ADIS | Intellectual or developmental disorders, currently involved in psychosocial or pharmacological treatment | GCBT > WL<br>Internet CBT > WL<br>GCBT = Internet CBT |

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| Bernstein, Layne, Egan, and Tennison (2005), USA<br>Sample: SAD, GAD, SoP<br>Age: 7-11 years | GCBT; GCBT+PT - 9 weekly sessions | No-treatment control | ADIS | Diagnoses of ADHD, conduct disorder, OCD, PTSD, alcohol/drug abuse, schizophrenia, major depression, pervasive developmental disorder, current suicidal or homicidal intent, current psychotropic medication, no spoken English, recent or current trial of CBT | CBT > NT |
| Nauta, Scholing, Emmelkamp, and Minderaa (2003), Netherlands<br>Sample: SAD, SoP, GAD, PD<br>Age: 7-18 years | CBT – 12 sessions<br>CBT+ PT – 12 sessions plus 7 parent | Wait-list control | ADIS | Current psychotherapy or medication for anxiety problems; CBT in the last two years | CBT > WL<br>CBT = CBT+PT |

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| | training sessions | | | | |
| Shortt, Barrett, Dadds, and Fox (2001)<br>Australia<br>Sample: GAD, SAD, SoP<br>Age 6.5-10 years | FGCBT - children 12 sessions, 50-60 minutes; parents 6 sessions | Wait list | DISC | 'Intellectual or severe physical impairment'. Currently receiving other treatment. | FGCBT > WL |
| Flannery-Schroeder & Kendall (2000)<br>USA<br>Sample: GAD, SAD, SoP | GCBT* - 18 sessions 90 minutes<br>ICBT* - 18 sessions 50-60 minutes<br>*Some parental advice | Wait list | ADIS | 'Disabling physical condition'. Psychotic symptoms. 'Current use of anti-anxiety or anti-depressant medication'. | ICBT = GCBT > WL |

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| Age: 8-14 years | given | | | | |
| Silverman et al. (1999)<br>USA<br>Sample: OAD, GAD, SoP<br>Age 6-16 years | FGCBT - 12 sessions, 55 minutes | Wait list | ADIS | Pervasive development disorder. Psychotic symptoms. Current treatment. | FGCBT > WL |
| Barrett (1998)<br>Australia<br>Sample: OAD, SAD, SoP<br>Age: 7-14 years | GCBT; FGCBT - 12 sessions, 2 hours | Wait list | ADIS | Intellectual or physical disabilities. Current 'anti-anxiety or anti-depression medication'. Parents 'involved in acute marital breakdown'. | GCBT = FGCBT > WL |
| Kendall et al. (1997)<br>USA | ICBT - 18 sessions, 60 minutes (mean) | Wait list | ADIS | Psychotic symptoms. Anti-anxiety medication | ICBT > WL |

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|---|---|---|---|---|---|
| Sample: OAD, AD, SAD Age: 9-13 years | | | | | |
| Dadds, Spence, Holland, Barrett, and Laurens (1997) Australia Sample: GAD, SAD, SoP, SP Age: 7-14 years | FGCBT - 10 sessions, 1-2 hours 3 parent sessions | Comparison school controls | ADIS | 'Disruptive behaviour problems'. Development problems or disabilities'. English not spoken at home. Clinical anxiety severity rating of higher than 5 on an 8-point scale. | FGCBT = control |
| Barrett, Dadds, and Rapee (1996) Australia Sample: OAD, SAD, SoP | ICBT; FCBT - 12 sessions, 60-80 minutes | Wait list | ADIS | 'Principal diagnosis of simple phobia or other (non-anxiety) diagnoses'. Intellectual or physical disabilities. 'Anti-anxiety or depression medication'. Parents 'involved in acute marital breakdown'. | FCBT > ICBT > WL |

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|---|---|---|---|---|---|
| Age: 7-14 years | | | | | |
| Kendall (1994)<br>USA<br>Sample: OAD, SAD, AD,<br>Age 9-13 years | ICBT - 17 sessions, 50-60 minutes | Wait list | ADIS | IQ below 80. 'Disabling physical condition'. Psychotic symptoms. Current 'anti-anxiety medications'. Primary diagnosis of specific phobia | ICBT > WL |



**KEY – Sample**

AD - Avoidant Disorder; AP – Agoraphobia; GAD - Generalised Anxiety Disorder; OAD - Over-Anxious Disorder; PD - Panic Disorder; SAD - Separation Anxiety Disorder; SoP - Social Phobia; SP - Specific Phobia

**KEY - Therapy type**

BT – Bibliotherapy; CCBT - Child Cognitive Behavioural Therapy; FCBT - Family Cognitive Behavioural Therapy; GCBT - Group Cognitive Behavioural Therapy; GCBT-P - Group Cognitive Behavioural Therapy delivered to parents; GCBT-PC - Group Cognitive Behavioural Therapy delivered to children and

parents; GCBT+PT - Group Cognitive Behavioural Therapy plus Parent Training; NT - no treatment; S - Sertraline pharmopsychological therapy; WL - wait-list

**KEY – Outcome measure**

ADIS - Anxiety Disorders Interview Schedule; DISC - Diagnostic Interview Schedule for Children; K-SADS - Kiddie-Schedule for Affective Disorders and Schizophrenia; KSCID – Kids Semi-Structured Clinical Interview for DSM-IV

# Appendix 3: Quality Assessment for the trials included in the meta-analysis (N=22)

| Criterion | Median* | Range* | Inter-rater reliability (KAPPA) |
|---|---|---|---|
| Randomisation | 0.25 | 0-2 | 0.80 |
| Used a remote site expert in randomisation | | | |
| Randomised by computer or other totally bias free method | | | |
| Separate allocator from executor of assignment | | | |
| Recruitment method | 3 | 2-3 | 0.72 |
| Sampled from clinical settings | | | |
| Didn't use convenience methods | | | |
| Inclusion and exclusion criteria were specified | | | |
| Groups comparable at baseline | 2 | 1-3 | 0.77 |
| Randomised on basis of key variables | | | |
| Checked that groups were equivalent at baseline on key variables | | | |
| Covaried for key variables in the analysis (if any group differences were found) | | | |
| Study blindness | 2 | 1-2 | 1.00 |
| Took steps to ensure that outcome assessors were blind to treatment allocation throughout the study | | | |
| Employed methods to check that assessor blindness had not been broken | | | |

| | | | |
|---|---|---|---|
| Employed at least some measures for which blindness could be attempted (i.e. not all self-report measures) | | | |
| Therapeutic integrity | 2 | 2-3 | 0.64 |
| Used a manual | | | |
| Checked therapist compliance | | | |
| Had methods for dealing with therapist failure to comply | | | |
| Reported participant compliance | | | |
| ITT analysis | 3 | 0-3 | 0.83 |
| Used an intention-to-treat analysis | | | |
| Had very few participants 'lost to follow-up' | | | |
| Had little missing data | | | |
| Outcome measures | 3 | 3-3 | 1.00 |
| Used well validated measures | | | |
| Used measures suited to the construct being assessed | | | |
| Used multiple informants | | | |
| Power | 0 | 0-3 | 1.00 |
| Stated how power was calculated | | | |
| Pre-set the number to be recruited | | | |
| Had power of at least 80% to detect a clinically meaningful change | | | |

*A higher score is indicative of a higher quality rating