

EFFECTIVENESS OF WEIGHTED BLANKETS AS AN
INTERVENTION FOR SLEEP PROBLEMS IN
CHILDREN WITH AUTISM

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Abstract

Sleep problems are common in children with ASD. Despite this, evidence for interventions, particularly alternative approaches such as weighted blankets is limited.

Aims. The aims of the study were to examine weighted blankets for: (1) their effectiveness as an intervention for sleep problems; (2) their impact on sleep state organisation; (3) their impact on night-time movement; (4) the sensory characteristics of children responding to the intervention; (5) parent's perceptions of the intervention; (6) behavioural interventions as a second intervention if required.

Method. Using a non-concurrent multiple baseline design, five children with autism aged between 7 to 13 years received a weighted blanket intervention with the option of a secondary behavioural intervention.

Results. One participant rejected the weighted blanket outright. Four participants showed no substantial improvements in sleep problems or changes in sleep state organisational. Despite this, parents of four participants still perceived the weighted blanket to be moderately effective. The sensory profiles of participants were not related to their response to the intervention. Participants' night-time movements were not found to be suppressed by the weighted blankets. Two participants went on to receive a behavioural intervention, one was successful and the other withdrew from the study before implementing the strategies. One other participant's sleep difficulties resolved over time without further intervention.

Implications. The current study neither supported weighted blankets as an intervention for sleep problems in children with autism nor supported contentions of its effectiveness for children with sensation seeking behaviours.

Chapter 1

Introduction

Sleep plays an important role in every aspect of a child's development (Kotagal & Broomall, 2012). Consequently, sleep problems in childhood may negatively impact on a range of developmental domains such as cognitive functioning, behaviour and mood. Childhood sleep disturbances are also associated with impairments in family functioning such as marital discord, increased parental irritability and poorer quality parent child interactions (Doo & Wing, 2006; Goodlin-Jones, Tang, Liu, & Anders, 2008; Wiggs & Stores, 2004).

Sleep problems are not a diagnostic feature of autism spectrum disorder but are nonetheless commonly reported. Despite this, interventions for sleep difficulties in children with autism have received little attention by researchers as evidenced by the lack of empirically-based interventions. Instead many of those traditional interventions proven successful amongst typically developing children are employed for children with autism. These traditional approaches may include behavioural and pharmacological interventions (e.g., melatonin) or a combination of both. Alternative approaches may also be sought, as parents are desperate to find immediate relief from the troubling and disruptive problems associated with sleep difficulties. Weighted blankets are one such approach used to alleviate sleep difficulties in children with autism.

The aim of this study was to examine the effectiveness of weighted blankets as an intervention for sleep disturbance in five children with autism. In addition, a behavioural-based intervention was made available for those children who did not

respond to the primary intervention. The behavioural intervention was offered as a means of overcoming the ethical dilemma associated with providing participants with a non-evidenced based intervention (i.e., weighted blanket). It is intended that both aspects of the study will share the similar aim of adding to the limited body of research on sleep interventions effective for children with autism.

Definition of autism spectrum disorder

Autism spectrum disorder (ASD) is a neurodevelopmental disorder characterized by impairments in social interaction and communication, with restricted interests and repetitive behaviours (American Psychiatric Association, 2013). As the name suggests, there is variability in the severity of deficits. Consequently there is significant heterogeneity in the presentation of individuals with autism spectrum disorder. For instance, some children are completely nonverbal, while others manifest only subtle deficits in communication. Individuals with autism may also present with associated features such as intellectual impairments, motor deficits, self-injurious behaviours, anxiety and depression.

The introduction of the DSM-V (American Psychiatric Association, 2013) has brought with it a number of changes to the diagnostic criteria of autism spectrum disorder. One change is the recognition of unusual sensory responses, which are characterized as hyper- or hypo- reactivity to sensory input or unusual interest in sensory aspects of the environment. These responses may be manifested as a source of fascination, pleasure and interest, or a source of anxiety and distress (Dickie, Baranek, Schultz, Watson, & McComish, 2009; Robert, Ciara, & Jaci, 2003).

Development of sleep in children

The development and nature of sleep changes over the lifespan. From infancy into adulthood there is a general decline in the duration of sleep along with changes in how sleep is initiated and maintained. Therefore, an understanding of the developmental characteristics of sleep is important when examining sleep-related problems and interventions.

Sleep architecture. Sleep architecture is the cyclical pattern of sleep as it shifts between two distinct physiological stages, rapid eye movement (REM) and non-rapid eye movement (NREM) (El Shakankiry, 2011). NREM sleep comprises of four stages according to the sleep depth. NREM Stage 1 sleep serves as a drowsiness transition from wakefulness to sleep and usually lasts between 1 and 7 minutes in the initial cycle. NREM stage 2 or light sleep lasts between 10 to 25 minutes and lengthens with each successive cycle. Stage 2 is characterized by a slowing heart rate, decrease in body temperature and a cessation in eye movements as the body prepares to enter into deep sleep. NREM sleep stages 3 and 4 are the deepest stages and are also known as slow-wave sleep (SWS) and most of which occurs during the first third of the night. During this period, arousal thresholds are very high with a longer period of sleep inertia after awakening.

Rapid eye movement sleep is associated with rapid and irregular eye movements, breathing irregularity and muscle weakness. Studies have found electrical brain wave activity during REM sleep to be similar to that of the waking state (Berk, 2009). Typically, NREM sleep precedes REM sleep within sleep-cycles that last on average 90 minutes with up to five cycles being completed in a typical night. There is

a progressive decrease in NREM sleep prevalence from the first half to the second half of the night, which is accompanied by a corresponding increase in REM sleep.

From an ontogenic perspective, sleep patterns vary throughout development with more sleep needed during critical periods of brain development. More specifically, REM sleep is vital for the growth of the central nervous system in infants. In infancy, REM accounts for 50 percent of infants' sleep time. The maturation of sleep architecture is characterized by a decline in REM sleep to that of adult-like levels of 20 percent by 3 to 5 years (Louis, Cannard, Bastuji, & Challamel, 1997). From 3 to 5 years, children typically spend 11 to 12 hours asleep over a 24 hour period, reducing to 10 to 11 hours for children aged 6 to 12 years (Dahl, 2007).

Sleep architecture in children with autism. Disrupted sleep architecture in children with autism has been reported in several polysomnography (PSG) studies (Buckley et al., 2010; Elia et al., 2000; Miano et al., 2007; Tanguay, Ornitz, Forsythe, & Ritvo, 1976; Thirumalai, Shubin, & Robinson, 2002). Several studies have found children with autism experience a significant reduction in REM sleep, compared to typically developing children (Buckley et al., 2010; Diomedi et al., 1999). Diomedi et al. (1999) also found an increase of undifferentiated sleep which was characterized by an abundance of spindle activity during both NREM sleep stage 3 and REM sleep. Sleep spindles are rapid bursts of recurring brain wave activity, which are typically a hallmark of NREM sleep.

Other variations in the sleep architecture of children with autism include increased REM density (i.e., frequency of eye movements) and a greater percentage of stage 1 sleep (Buckley et al., 2010). Elia et al. (2000) also reported subtle alterations in the cyclic alternating pattern of NREM sleep. The first REM latency and percentage of sleep stage 1 was found to be lower in children with autism compared

to typically developing children (Elia et al., 2000). These studies highlight just some of the differences in sleep architecture in children with autism compared to typically developing children.

Assessment of sleep

A number of methods exist for assessing sleep in children. The assessment approach selected will in part be determined by the cost associated with the technique, the type of information required, the individual characteristics of the child and the overall acceptability of the method to the parents and child (Stores & Wiggs, 1998). For instance, utilising techniques that require the child's cooperation may not be possible with some children, particularly for those children with developmental disabilities. Stores and Wiggs (1998) suggest that gradually introducing techniques in a non-threatening setting may increase the likelihood of a child's willingness to cooperate. The different methods for assessing sleep in children and their suitability for use with children with autism are outlined below.

Polysomnography. Polysomnography is considered the “gold standard” of sleep measures, against which other assessment methods should be validated (Stores & Wiggs, 1998). It is a diagnostic tool that collects information on sleep stages and physiologic activities (i.e., eye movements, brainwave activity and oxygen saturation levels) (Hodge, Parnell, Hoffman, & Sweeney, 2012). It provides the most reliable method for studying sleep, however, it is not without its constraints.

Polysomnography recordings are usually limited to one or two nights, owing to the costs associated with the technique. The natural sleep setting is also compromised, as this technique must be conducted overnight in a sleep laboratory and requires the

application of sensors. Consequently, children with autism are often unable to tolerate this procedure (Arbelle & Ben-Zion, 2001).

Videosomnography. Videosomnography requires the placement of a portable time-lapsed video in the child's bedroom. Information is then collected on a range of variables including sleep wake states, percentage of time asleep, number and duration of waking times after sleep onset (Hodge et al., 2012). This technique also enables information to be gathered about the child's night time behaviours (Stores & Wiggs, 1998), however, it is limited to detecting behaviours in a predetermined location (e.g., child's bedroom). Children may also hide from the camera or become preoccupied by the equipment, compromising the validity of the results. Despite those limitations, videosomnography has shown to be well-tolerated by children with autism (Sitnick, Goodlin-Jones, & Anders, 2008).

Actigraphy. Actigraphs are watch-like devices worn by children (e.g., wrists or ankles) that monitor night-time limb movements to estimate sleep-wake cycles. They are a cost effective and non-intrusive method that enables information to be collected over extended periods of time in the home environment. Their use for children with autism has been met with mixed results. In a study by Sitnick et al. (2008), actigraphs were found to be well-accepted by children with autism. In contrast, other studies have shown 10% to 33% of children with autism were unable to tolerate this method (Hering, Epstein, Elroy, Iancu, & Zelnik, 1999; Wiggs & Stores, 2004).

Sleep diaries. Most research on sleep problems in children with ASD has been conducted using subjective parent reports such as sleep diaries (Hodge et al., 2012). Parents collect information on a range of sleep parameters including bedtime behaviours; resistance to going to sleep or going to sleep alone, sleep onset latency,

sleep duration, number and duration of night awakenings, bedtime (pm), and wake time (am). Sleep diaries enable prolonged recording over several weeks.

Goodlin-Jones et al. (2008) suggest that whilst parent reports may be accurate for assessing sleep onset and wake times in the morning, they are less accurate for gauging other aspects of sleep (such as differentiating between REM/NREM and periods of quiet wakefulness). For this reason sleep diaries are recommended as an adjunct to the actigraph (Acebo et al., 1999).

Sleep questionnaires. Sleep questionnaires are another means of gathering information and screening for sleep problems in children. In a review by Hodge et al. (2012), the Children's Sleep Habits Questionnaire (CSHQ; Owens, Spirito, & McGuinn, 2000) was found to be the most commonly-used standardized sleep measure in children with autism. On this measure parents rate how frequently their children displayed specific sleep behaviours over the previous week. The CSHQ derives a total sleep disturbance score based on the scores of eight subscales (i.e., bedtime resistance, sleep duration, sleep onset delay, sleep anxiety, parasomnias, sleep disordered breathing and daytime sleepiness).

Souders et al. (2009) found the CSHQ total score had good agreement with actigraph requirements in identifying sleep problems in a sample of children with autism. The CSHQ has also demonstrated good agreement with actigraph-based criteria regarding the persistence of sleep problems (Goodlin-Jones, Schwichtenberg, et al., 2009).

Definition of sleep problems

The International Classification of Sleep Disorders: Diagnostic and Coding Manual (American Academy of Sleep Medicine, 2005) has classified sleep problems

into two main categories: dysomnias and parasomnias. Parasomnias are disorders that interfere with sleep, and include disorders of arousal, partial arousal and difficulties with transitioning between sleep-stages. In contrast, dysomnias are characterised by difficulty initiating or maintaining sleep and/or excessive daytime sleepiness.

Dysomnias are the focus of interventions demonstrated in this study, therefore definitions of sleep problems commonly associated with initiating and maintaining sleep are provided below.

Bedtime resistance. Bedtime resistance is characterised by non-compliance in response to parental requests to get ready for bed, behaviours associated with stalling, resistance or refusal to go to bed and stay in bed. Bedtime resistance is often associated with requests by a child for parental attention.

Sleep onset delay. Sleep onset delay is characterised by a delay in falling asleep once in bed. “Sleep onset latency” and “sleep refusal” may also be used to describe this sleep-related difficulty. Sleep onset delay is calculated by taking the difference between bedtime and the time of sleep onset.

Night awakening. Night awakening is characterised by awakening after sleep onset and prior to morning arousal. Night waking behaviours are likely to increase the probability of co-sleeping in response to comfort or attention required by the child to return them to sleep (Cotton & Richdale, 2006).

Early morning waking. Early morning waking is characterized by the termination of a sleep episode prior to a usual time of arising and is accompanied by the inability to return to sleep. It reflects an interference of sleep at the end, rather than at the commencement of sleep. Social norms and expectations play an important role in determining an acceptable wake time (Arber, Meadows, & Venn, 2012).

Co-sleeping. Co-sleeping is defined as a parent or other family member sleeping alongside the child. Co-sleeping of infants and parents is a common practice in a number of cultures around the world (Owens, 2004). Therefore, for co-sleeping to be considered a problem, it needs to be negatively impacting the parents and child rather than as an active parental choice (Carr, 2006).

Prevalence and nature of sleep problems in children with autism

Sleep-related problems are not a diagnostic feature of autism spectrum disorder but they are a common clinical feature (Hering et al., 1999). Parent reports indicate between 44% and 86% of children with autism experience sleep-related problems (Liu, Hubbard, Fabes, & Adam, 2006; Richdale, 1999). In comparison, sleep disturbances reported in typically developing children range from between 9% to 50% (Krakowiak, Goodlin-Jones, Hertz-Picciotto, Croen, & Hansen, 2008; Richdale & Schreck, 2009). The wide variations in estimates are thought to be due to a combination of factors such as differences in research methodologies and the definitions of sleep disturbances employed. The sample size and participant composition within studies have also been implicated in contributing to the wide-ranging prevalence estimates (Richdale & Schreck, 2009).

There is evidence to suggest that sleep problems in children with autism have an early onset (Doo & Wing, 2006) and are persistent (Sivertsen, Posserud, Gillberg, Lundervold, & Hysing, 2012). The most commonly reported sleep-related problems in children with autism are difficulties associated with bedtime resistance, sleep onset delay and co-sleeping (Cotton & Richdale, 2006; Krakowiak et al., 2008; Liu et al., 2006; Malow et al., 2006; Williams, Sears, & Allard, 2004). Longer and more frequent night awakenings have also been identified as a common concern by parents

of children with autism (Cortesi, Giannotti, Ivanenko, & Johnson, 2010; Hering et al., 1999; Honomichl, Goodlin-Jones, Burnham, Gaylor, & Anders, 2002). Consequently, some studies have suggested sleep duration is shorter for children with autism compared to typically developing children (Anders, Iosif, Schwichtenberg, Tang, & Goodlin-Jones, 2011; Goodlin-Jones, Tang, Liu, & Anders, 2009), although this finding is not universally agreed upon (Schreck & Mulick, 2000). Less common, sleep-related difficulties of early morning waking and daytime sleepiness have also been described (Cotton & Richdale, 2006; Williams et al., 2004).

Development and maintenance of sleep problems in children with autism

Understanding the possible causes and maintaining factors associated with childhood sleep problems is an important part of formulating and planning interventions for both parents and health professionals. Sleep problems in children with autism may occur as part of challenging behaviours associated with the disorder; may be a manifestation of factors intrinsic to the disorder; or may be a combination of both (Richdale, 2001). Accordingly, the risk factors and/or causes of sleep problems are likely to be multi-factorial. These may include factors related to the child, the parent and/or environmental influences.

Child factors.

Biological factors. There is a general consensus that biological and/or genetic abnormalities may be associated with sleep problems in children with autism. These factors may include the disruption of several neurotransmitter systems that are implicated in promoting sleep and establishing regular sleep-wake cycles such as gamma-aminobutyric acid (GABA), serotonin and melatonin (Malow & McGew, 2008).

Gamma-aminobutyric acid is an inhibitory neurotransmitter and the activation of GABAergic receptors has been found to promote sleep. In children with autism, these inhibitory neurotransmitters appear to be disrupted (Tordjman, Anderson, Pichard, Charbuy, & Touitou, 2005).

Similar disruptions have been identified in the hypothalamic-pituitary-adrenal axis (HPA) that regulates circadian rhythms and alterations in serotonin and melatonin production (Levitt, Eagleson, & Powell, 2004). Serotonin promotes sleep by dulling systems that stimulate cortical activation and arousal. Thus irregularities in serotonin synthesis may influence the physiological effects of serotonin on sleep promotion in children with autism. Melatonin secretion is associated with the regulation of the body's circadian rhythm (i.e., 24-hour sleep/wake cycle) (Cajochen, Kräuchi, & Wirz-Justice, 2003). Typically, the onset of darkness stimulates the production of melatonin while light acts to inhibit this process. In a review by Johnson and Malow (2008), several studies reported elevated daytime melatonin and significantly lower nocturnal melatonin in children with autism. These findings are consistent with an earlier study that found a flattening of the circadian rhythm when examining 24-hour melatonin patterns in children with autism (Nir et al., 1995).

Genetic abnormalities have also been implicated in sleep disturbances in children with autism. More specifically, clock genes are thought to form the biological clock controlling circadian rhythms (Bourgeron, 2007). It has been suggested irregularities in the expression of these genes may cause the child's nervous system to incorrectly transmit the entrainment cues (e.g., light and dark) that help regulate the sleep wake cycle (Richdale, 2001).

Unusual sensory responses. Sensory sensitivity has been identified as one factor that may contribute to sleep problems in children with autism. In one study,

Reynolds and Lane (2011) examined the relationship between responses to sensory stimuli and sleep quality, and found that sensory-avoiding behaviours were highly correlated with sleep problems in children with autism. Despite limited research in this area, similar findings have been reported in typically developing children.

Shochat, Tzischinsky, and Engel-Yeger (2009) found tactile sensitivity in typically developing children was a significant predictor for sleep difficulties. Likewise, Shani-Adir, Rozenman, Kessel, and Engel-Yeger (2009) reported a correlation between sensory hypersensitivity and lower sleeping quality in children with atopic dermatitis.

Characteristics and symptoms of autism. Social cues and routines are thought to help young infants develop stable sleep-wake patterns. Secondary cues such as meals, social signals and familiar routines reinforce the entrainment of the sleep/wake cycle. Children with social and communication deficits such as those with autism may therefore find it difficult to use such signals to entrain their sleep-wake rhythms (Richdale, 1999). In one study, Dawson, Meltzoff, Osterling, Rinaldi, and Brown (1998) found decreased attention to social cues in autistic individuals. However the extent to which these deficits may impact on entrainment of the sleep/wake cycle remains unknown.

Psychological and medical factors. It is well-accepted that psychological difficulties interfere with sleep initiation (Hollway & Aman, 2011; Johnson & Malow, 2008; Wiggs & Stores, 2004). Less recognized is the vulnerability of children with autism to psychological problems such as anxiety and depression (Richdale & Schreck, 2009), which in turn places them at risk of developing sleep problems. Similarly, neurological conditions (e.g., epilepsy), medical disorders (e.g., gastrointestinal reflux disease) and associated medications may impact negatively on sleep (Malow, 2004; Richdale & Schreck, 2009).

Family factors. Family factors such as parental stress have been associated with sleep problems in children with autism (El-Sheikh, Buckhalt, Mize, & Acebo, 2006; Wiggs & Stores, 1998). In a study by Doo and Wing (2006) parental stress was found to significantly predicate sleep problem severity in children with autism.

Parenting practices have also been associated with the development and maintenance of sleep problems in children with autism. It must however be noted that this factor is not unique to children with autism. Parental stress combined with the challenging behaviours associated with autism may compromise a parent's ability to successfully and consistently implement positive bedtime routines, which in turn may increase the likelihood of sleep problems. This may result in a coercive interaction where individuals behave in such a way that is aversive to another person in an attempt to control the other's behaviour and/or to achieve a desired outcome. For instance, as a child's aversive behaviours increase in intensity and frequency, the parent yields, unwittingly reinforcing the dysfunctional behaviour. Thus begins the coercive cycle as the child learns to predict their parent's reactions resulting in the increase of problematic behaviours causing parents to use ineffectual behavioural management techniques (Patterson, De Barsyshe, & Ramsey, 1989).

Environmental influences. It is well agreed in the literature that environmental factors such as the physical environment (e.g., space, noise, perceived threats), family composition, lifestyle and socio-economic factors significantly impact on sleep and sleep practices (Owens, 2004). These factors may be particularly significant for children with autism who experience heightened responses to environmental factors (i.e., noise and textures of bedding and clothing).

The wider implications of sleep problems for children and parents

Impact of sleep problems on children with autism. Sleep is essential for child development and wellbeing. It is therefore unsurprising that sleep disturbances are associated with impairments in daytime functioning. For instance, sleep disturbances have been found to exacerbate the characteristics associated with autism such as aggression, hyperactivity and behavioural difficulties (Cotton & Richdale, 2006; Goldman et al., 2011; Hoffman et al., 2005; Mayes & Calhoun, 2009; Schreck, Mulick, & Smith, 2004). Tudor et al. (2012) also found a positive correlation between the severity of sleep problems and the severity of autism symptoms in an examination of sleep habits and autism symptoms in 109 children. Similarly, Goldman et al. (2009) reported there was a higher risk of problematic behaviours in those children whose parents reported them to be poor sleepers (compared to good sleepers).

Sleep-related problems may also be associated with impairments in academic functioning. Children with sleep problems are more likely to exhibit daytime behaviour problems and /or daytime sleepiness that may interfere with their educational and behavioural development (Patzold, Richdale, & Tonge, 1998; Wiggs & Stores, 1996).

Impact of childhood sleep problems on parents. Caring for a child with a developmental disability can in itself be stressful as parents attempt to respond to the challenges (Abbeduto et al., 2004). These challenges appear to be exacerbated for parents of children with autism who have been found to suffer more stress compared to parents of children with psychiatric difficulties, down syndrome and other developmental disabilities (Bouma & Schweitzer, 1990; Eisenhower, Baker, & Blacher, 2005).

There is a general consensus that sleep difficulties place an additional burden upon parents of children with autism. In a study by Hoffman et al. (2008), children's sleep problems were found to be a significant predictor of maternal stress after controlling for child age and gender, mothers' sleep and severity of autism. Hoffman et al. (2008) suggested the demands and associated stresses of caring for a child with autism appear to be greatest for mothers as they maintain primary responsibility for parenting their children with a disability. Other studies have shown that sleep disturbances in childhood has been associated with marital discord, parental irritability and stress (Doo & Wing, 2006; Goodlin-Jones, Tang, et al., 2009), poor quality parent-child interactions and poorer overall quality of life (Goodlin-Jones et al., 2008; Wiggs & Stores, 2004).

In summary, there is clear evidence that sleep disturbances have significant impacts on children and their families. These difficulties appear to be further exacerbated for parents of children with autism who face unique challenges compared to parents of typically developing children. Therefore the amelioration of sleep-related problems is essential to promote positive development of children with autism and improve the quality of life for them and their families.

Chapter 2

Literature review

The purpose of this review was to explore the literature relating to interventions for sleep problems in children with autism. The main focus of this investigation was an examination of somatosensory interventions, specifically weighted blankets. The effectiveness of behavioural interventions as an intervention for sleep problems in children with autism was also examined to provide a comprehensive understanding around the evidence base for the more traditional approaches.

Search process

Literature searches were conducted using the following electronic databases; PsychInfo, Medline, CINTAL, and the University of Canterbury Library Catalogue. The reference lists of selected articles were also searched to identify any additional articles for inclusion. Given the paucity of research in this area the literature searches were not restricted by date. Keywords used to search databases included diagnostic terms (“autism spectrum disorder”, “ASD”, “developmental disorder”, “autism”, “autistic disorder”) and sleep terms (“sleep”, “sleep disorders” and “sleep problems”). These keywords were combined with the intervention search terms: somatosensory therapies and behavioural interventions as outlined below.

Search terms related to somatosensory therapies included “weighted blankets” “sensory processing”, “sensory integration”, “somatosensory therapy”, “somatosensory stimulation” “deep pressure input”, “weighted vests”, “massage

therapy”, “joint compressions”, “brushing” and “pressure garments”. Whilst the focus of this review was to examine the literature on weighted blankets, given the scarcity of research in this area the review was extended to include studies demonstrating the use of other somatosensory therapies. Searches were initially combined with terms related to sleep, however later those search terms were removed to capture all the literature in this area. Studies implementing classical sensory integration approaches were considered beyond the scope of the study.

Search terms for behavioural interventions included “behavioural therapy”, “behavioural intervention”, “extinction”, “sleep scheduling”, “stimulus fading”, “chronotherapy” and “sleep hygiene”. These search terms were combined with the diagnostic and sleep keywords outlined above. Once more, given the lack of research within this area, searches were not restricted by date.

Somatosensory stimulation

Sensory stimulation involves the application of a sensation to an individual with the purpose of eliciting a behavioural response (Bundy & Murray, 2002). Somatosensory stimulation is a subtype of sensory stimulation that is thought to target the tactile and proprioceptive sensory functions through deep pressure input. Deep pressure input refers to a sensation between a light touch and a heavy painful sensation (Krauss, 1987). Deep pressure input is purported to have a calming and organizing effect on the central nervous system by lowering states of arousal resulting in positive behavioural and emotional outcomes (Deris, Hagelman, Schilling, & DiCarlo, 2006; Rogers & Ozonoff, 2005; VandenBerg, 2001). An increase in parasympathetic nervous system (PNS) activity which maintains homeostasis is one mechanism that has been identified in this process (VandenBerg, 2001).

Somatosensory interventions focus on adapting the child's environment in ways that facilitate his or her adaptive responses as opposed to remediating an underlying impairment. They encompass a wide range of therapies including weighted blankets, weighted vests, hug machine, massage, pressure gloves, brushing and splints. It is important to distinguish these alternative therapies known as somatosensory stimulation from classical sensory integration therapy. Classical sensory integration therapy is an active therapy based on meaningful self-directed and adapted interactions (Ayres, 1972) that involve activities with trampolines, balls and suspended equipment that provide proprioceptive, tactile and vestibular experiences to stimulate sensory integration.

Theoretical framework of somatosensory interventions

Somatosensory interventions are based loosely on a sensory integration framework. Sensory integration was first defined by Ayres (1972) as the “organisation of sensory information for its use” (p. 5). Ayres proposed that sensory integration facilitates the nervous system by receiving, registering, modulating, organizing and interpreting information that comes to our brains from our senses so that a person can interact with their environment.

In particular, sensory modulation is the process that enables individuals to selectively respond to certain stimuli while ignoring others. This in turn allows individuals to respond appropriately to situations. Ayres (1972) hypothesised that a failure to respond appropriately to sensory information may be characterised by over-reactivity (e.g., distress at loud sounds), under-reactivity (e.g., high pain threshold), or sensation craving behaviours (e.g., prolonged experiences such as rocking or hand flapping). Proponents of sensory integration therapy contend this framework may be

used to understand and explain the relationship between behaviour and underlying sensory experiences.

Based on Ayers earlier work, Dunn (1999) proposed a model of sensory processing dysfunction according to an individual's behavioural responses to sensory stimuli and neurological thresholds. Neurological threshold describes the amount of sensory stimulation required for an individual's nervous system to respond. Dunn (1999) identified four patterns of sensory processing: *Low Registration* describes a slow response or unawareness of sensory stimulation; *Sensation Seeking* describes craving of or interest in sensory experiences; *Sensory Sensitivity* is characterized by distress or prolonged reactions to sensory stimulation (e.g., distress from loud noises); and finally, *Sensation Avoiding*. Individuals' may also fluctuate between these states of arousal (Schneck, 2001).

Accordingly, professionals who base their interventions on Dunn's (1999) framework perceive atypical responses to be associated with sensory dysfunction. More specifically, it has been suggested that children who display *Sensation Seeking* behaviour will seek out deep pressure input sensation (Dunn, 1999). Ayres and Tickle (1980) also found hypo-reactive children sought deep pressure input, but this same sensation was rejected by hyper-reactive children with autism.

There is however considerable controversy surrounding the theoretical framework of sensory integration. For instance no studies have examined the direct associations between the underlying brain functions and behavioural outcomes of deep pressure input in children with autism. Increased PNS activity has however been associated with increased attention span, alertness and performance on cognitive tasks in typical persons (Field et al., 1997). Similarly, massage therapy was found to increase PNS activity in cocaine-exposed infants (Field, 1990, as cited in Field et al.,

1997) and decreased arousal in typical adults when moderate to firm pressure was used (Diego, Field, Sanders, & Hernandez-Reif, 2004). Whilst these findings are by no means conclusive they do offer some tentative evidence of the association between deep pressure input and underlying neuronal activity. However, somatosensory interventions are in general not well grounded on a recognised theoretical framework.

In addition, there is on-going debate around the legitimacy of sensory processing dysfunction as a “real” disorder. Despite the presence and frequency of unusual sensory responses in children with autism being well documented (Baker, Lane, Angley, & Young, 2008; Baranek, David, Poe, Stone, & Watson, 2006; Klintwall et al., 2011; Leekam, Nieto, Libby, Wing, & Gould, 2007; Tomchek & Dunn, 2007), these unusual sensory responses in children with autism are only now being formally recognized. For the first time, the American Psychiatric Association (2013) has included “hyper- or hypo-reactivity to sensory input or unusual interest in sensory aspects of the environment” (p. 50) in the diagnostic features of autism.

Definitions and effectiveness of somatosensory interventions

Weighted blankets. Weighted blankets are a commonly-used and advocated approach to improve sleep outcomes in children with autism (Mosaic Weighted Blankets., 2014; SensaCalm, 2014). Similar to the design of a quilted blanket, weighted blankets consist of a blanket with a series of pockets filled with rice, wheat or plastic pellets that provide a controlled weighted sensation. There is a general consensus within the literature and from anecdotal reports that the weight of the blanket should be individualized to the recipient. Common clinical practice is the use of a standard formula (i.e., 10% of the recipient’s body weight plus one kilogram) to

calculate the recommended weight of the blanket (Mullen, Champagne, Krishnamurty, Dickson, & Gao, 2008).

The specific mechanisms through which weighted blankets are purported to aid sleep are unknown. Researchers have speculated that deep pressure lowers arousal levels and provides a calming effect (Baranek, 2002; Case-Smith & Bryan, 1999; Field et al., 1997; McClure & Holtz-Yotz, 1991). It is possible that lower arousal levels may in turn promote the behavioural quietude for necessary sleep, but this is only speculation.

To date, Mullen, Champagne, Krishnamurty, Dickson, and Gao (2008) have conducted the only published study on weighted blankets. In a concurrent mixed design the safety and therapeutic effects of weighted blankets were examined in a community sample of 32 typical participants aged between 18 to 58 years. In a mixed order presentation, participants lay down for 5 minutes with and without a 13.6kg weighted blanket. Results indicated no harm to participants as measured by vital signs (i.e., pulse oximetry, pulse rate and blood pressure). Skin conductance was used as a quantitative measure of effectiveness of sympathetic activity. On this measure, no significant differences in anxiety were found between the conditions. Interestingly, 63% of participants reported lower anxiety on the State Trait Anxiety Inventory with the blanket compared to without the blanket. These results suggest that the perceived sense of relaxation is greater than the actual benefits associated with the weighted blanket. The authors acknowledge a number of limitations of the study including the brief application of the treatment (e.g., 5 minutes) and the use of a standard size weighted blanket across all participants. Furthermore, the low levels of anxiety initially reported by the community sample may have created a floor effect.

James (2012) demonstrated the use of weighted blankets as part of a wider study in three children aged between 5 to 6 years with autism experiencing delays in sleep onset. Weighted blankets were individually tailored (i.e., 10% of participant's body weight) and positioned on the lower half of participant's bodies (i.e., hips and upper legs) for 30 minutes once they were in bed. The author cited safety reasons for following this protocol. James (2012) found the weighted blanket did not lead to substantial improvements for any of the participants. The design (e.g., size and rustling sounds) and the protocol (i.e., partial placement and for only 30 minutes) were both identified as possible factors negatively impacting on the effectiveness of the intervention.

In summary, only two studies have examined the use of weighted blankets (James, 2012; Mullen et al., 2008). Based on this research, there is no evidence that supports weighted blankets as an intervention for children with autism. Nor is there any evidence around the conditions under which the blanket will offer optimal benefit and what those benefits are, if any in aiding sleep.

Other somatosensory interventions. As previously discussed, given the paucity of research on weighted blankets this review has been extended to include other somatosensory therapies. An examination of the literature attempted to identify if there is any evidence to support the use of somatosensory therapies in general for children with autism.

Weighted vests. Three reviews comprising a total of 11 studies have exclusively examined the effectiveness of weighted vests on children with autism (Morrison, 2007; Schaaf, 2011; Stephenson & Carter, 2009). Each study reported on a range of different outcomes including attention to task, self-stimulatory behaviours and self-injurious behaviours. Of those studies reviewed, eight showed no evidence

supporting the use of weighted vests (Carter, 2005; Cox, Gast, Luscre, & Ayres, 2009; Deris et al., 2006; Hodgetts, Magill-Evans, & Misiaszek, 2011b; Kane, Luiselli, Dearborn, & Young, 2004; Leew, Stein, & Gibbard, 2010; Quigley, Peterson, Frieder, & Peterson, 2011; Reichow, Barton, Sewell, Good, & Wolery, 2010). Moreover, one study reported a possible negative influence of the weighted vest citing an increase in stereotypic behaviour for three participants (Kane et al., 2004).

No studies have demonstrated overall positive results for the use of weighted vests, however, three studies reported mixed findings, which are outlined below (Fertel-Daly, Bedell, & Hinojosa, 2001; Hodgetts, Magill-Evans, & Misiaszek, 2011a; Myles et al., 2004). Based on a visual analysis, studies were classified as having mixed results based on those criteria used by Lang et al. (2012). Single case studies were defined as mixed results if improvement was found for some but not all participants on dependant variable(s). Between-group designs were classified as having mixed results if statistically significant improvement was found for some, but not all, dependent variables in the treatment group.

As part of a wider study, Fertel-Daly et al. (2001) demonstrated the use of a weighted vest on a 2-year-old boy with autism. In a single subject ABA reversal design, a vest with four 25lb weights was placed on the participant for 2 hours, three times a week, for 2 weeks. Following the intervention, improvements were reported on all outcome measures; attention to task, number of distractions and self-stimulatory behaviours. Unfortunately, confidence in the findings is limited due to a number of methodological weaknesses including the variability of data points during baseline. If target behaviours are not stable when the intervention commenced the ability to draw conclusions about the effectiveness of the intervention is compromised. Additionally,

the study did not control for observer drift as inter-rater reliability was only conducted during baseline observations.

In another single case study, Myles et al. (2004) utilised an ABAB design to examine the effects of weighted vests on self-stimulation and on-task behaviour on three children with autism. Weighted vests (five to ten percent of participants' body weight) were worn for brief periods of time (i.e., 5, 15, or 30 minutes) either during the task or prior to engaging in an activity before being removed. No improvements were reported for one participant, whilst improvements were reported for the two other participants for time spent staying on-task and reduction in self-stimulation behaviours. For the reasons outlined above, caution is also needed when interpreting the findings due to unstable data points.

In a more rigorous design, Hodgetts et al. (2011a) investigated the effects of weighted vests on time staying in-seat and time off-task in ten children with autism aged between 3 to 10 years. In an ABCBC design, "A" represents baseline, phase "B" represents vests with Styrofoam balls and "C" represents weighted vests (i.e., five to ten percent of participants' body weight). Phases B and C were randomly assigned to control for observer bias. During each of these phases, vests were worn for 20 minutes a day for 2 weeks. The weighted vest was found to decrease off-task behaviours for three of the eight participants. For three participants who were measured on in-seat behaviour, there were no improvements reported.

In summary, no studies have yet reported overall positive improvements in the behaviour of children with autism when wearing weighted vests. There have however been a number of studies that have reported mixed findings (Fertel-Daly et al., 2001; Hodgetts et al., 2011a; Myles et al., 2004). Furthermore, one study showed a negative response to the weighted vest (Kane et al., 2004). These findings are by no means

conclusive and a lack of methodological rigour raises further questions the ability to draw strong conclusions.

Other somatosensory therapies. Hodgetts and Hodgetts (2007) examined the rationale and effectiveness of three less-commonly used somatosensory therapies in children with autism, in four separate studies (Escalona, Field, Singer-Strunck, Cullen, & Hartshorn, 2001; Field et al., 1997; McClure & Holtz-Yotz, 1991; Zissermann, 1992). These studies reported on a range of outcomes including problem off-task behaviour, self-injurious behaviour, attention to task and sleep problems. Of those four studies, all were classified as having positive findings based on the criteria used by Lang et al. (2012).

The use of elbow splints (McClure & Holtz-Yotz, 1991) and pressure gloves (Zissermann, 1992) were demonstrated in two case studies. Both these studies reported improvements on all dependent variables.

Two randomized control trials demonstrating the use of massage therapy also reported statistically significant outcomes for all participants around improvements to on-task behaviour and a decrease in stereotypic behaviours (Escalona et al., 2001; Field et al., 1997). In addition, Escalona et al. (2001) reported an increase in social relatedness and fewer sleep problems characterized by a decline in fussing/restlessness, crying and getting out of bed). Likewise, Field et al. (1997) noted improvements in touch aversion and ability to orientate to sounds.

More recently, Piravej, Tangtrongchitr, Chandarasiri, Paothong, and Sukprasong (2009) examined the effects of Thai Traditional Massage on behaviour problems in thirty children with autism aged 3 to 10 years in a randomized controlled trial. Both the control group and intervention group also received Sensory Integration

Therapy that targeted specific sensory deficits. Activities included vestibular integration, tactile and proprioceptive stimulation. Results on the Conner's Parent Questionnaire revealed improvement in conduct problems and a reduction in anxiety in the intervention group compared to the control group. However, results on the Conner's Teacher Rating Scale reported no significant differences between the groups.

In another study, no improvements were reported in stereotypy behaviours following a brushing procedure in a withdrawal design on a 4-year-old with autism (Davis, Durand, & Chan, 2011). The Wilbarger Protocol was followed in which the participant was systematically brushed with a soft surgical brush using firm pressure on his arms, hands, back, legs, and feet until the entire surface of skin had been brushed at least once. A strength of this study was the completion of a functional analysis prior to implementing the intervention to determine the contingencies maintaining the behaviour and selecting an intervention accordingly (Davis et al., 2011).

Hug Machines. Grandin's Hug Machine provides deep pressure input. The Hug Machine is a V-shaped padded construction that applies deep pressure across the lateral parts of the body. Edelson, Edelson, Kerr, and Grandin (1999) evaluated the effectiveness of this device on alleviating anxiety in 12 children with autism. Participants were randomly assigned to either experimental (received deep pressure) or placebo group. Each child received twelve 20 minute sessions in the Hug Machine over 6 weeks. Participants were able to apply deep pressure with the machine as much as desired by pulling the lever. The control group lay in a machine in which the pressure lever was disengaged so that they were unable to apply pressure. The results showed a significant reduction in tension and anxiety for those children in the

experimental group on the Connor's Parents' Rating Scale and Galvanic Skin Response Scale as compared to the control group. Edelson et al. (1999) concluded that participants with the highest initial levels of physiological anxiety benefited most from the intervention. These results contribute to the promising results of earlier studies demonstrating the use of the Hug Machine.

In an earlier study, the increased use of the Hug Machine was associated with a decrease in hyperactive behaviour in some children with autism (Inamura, Wiss, & Parham, 1990a, September, 1990b, December). In another study, Creedon (1994, July as cited in Edelson et al., 1999) found that children who had longer periods of sustained pressure from the Hug Machine on those days associated with behaviour problems were then able to sit more calmly and display more adaptive movements than those children who did not use the Hug Machine regularly.

Krauss (1987) also investigated the effects of deep pressure using a Hug Machine on College students. On an objective measure of anxiety, there was no change in heart rate following deep pressure. However, the self-report State Trait Anxiety Inventory participants reported a reduction in anxiety. This suggests the perceived sense of effectiveness is greater than the actual effectiveness of the device. Krauss (1987) speculated a floor effect may explain the limited change in anxiety following deep pressure.

In summary, the review has highlighted not only the paucity of research on weighted blankets but also the lack of support for the use of weighted blankets as an aid for sleep disturbances. One finding of interest was the perceived sense of relaxation that participants noted when using a weighted blanket (Mullen et al., 2008).

Research findings on the effectiveness of weighted vests have also proved inconclusive. No studies have shown overall positive findings (Carter, 2005; Cox et al., 2009; Deris et al., 2006; Hodgetts et al., 2011b; Kane et al., 2004; Leew et al., 2010; Quigley et al., 2011; Reichow et al., 2010) however mixed findings were reported for some (Fertel-Daly et al., 2001; Hodgetts et al., 2011a; Myles et al., 2004). Concerns were also noted around the methodology for some of these studies, which undermines the validity of results and confidence in the findings.

Less commonly used somatosensory stimulation therapies such as pressure gloves, elbow splints, brushing, massage and the use of deep pressure using a hug machine were also examined. As with the other research in this area, these studies reported mixed findings on a range of outcome measures. Overall, this literature review has highlighted significant gaps in the literature and inconclusive findings around the use of somatosensory therapies for children with autism.

Treatment acceptability of somatosensory therapies

Empirically-based treatments for managing sleep difficulties in children with autism are limited, leaving parents and practitioners with a small evidence base from which to make informed decisions. Green (2007) found the absence of empirical evidence does not differentiate between commonly used and rarely used treatments. Rather, treatment approaches were selected for other reasons including ease of implementation, time commitments, accessibility and awareness of information about treatments.

Occupational Therapists' perceptions. Sensory stimulation approaches are widely-used by occupational therapists and are one of the most commonly recommended interventions for children with autism (Case-Smith & Miller, 1999;

Watling, Deitz, Kanny, & McLaughlin, 1999). In a mail survey of 514 Occupational Therapists, of the 340 respondents, 56% used weighted vests and of those 82% reported using weighted vests with children with autism (Olson & Moulton, 2004b). In a follow-up to their earlier study, (Olson & Moulton, 2004a) surveyed 51 Occupational Therapists about their use of weighted vests. Seventy percent of those respondents using weighted vests attributed them to decreasing stereotypic behaviours (e.g., hand flapping, rocking, hitting), reducing tantrums, and increasing positive behaviours such as improved attention, sustaining eye contact, and following instructions. However, some respondents questioned whether weighted vests alone could have produced the changes observed (Olson & Moulton, 2004a). Overall, Occupational Therapists appear to be routinely using somatosensory stimulation therapies (including weighted blankets) as one intervention approach for children with autism.

Parent perceptions. A number of studies have examined parent perceptions of sensory interventions. In a study by Green et al. (2006), 552 parents completed an internet survey on treatments they use on their children with autism. Of those respondents 12.8% of parents were currently using weighted vests or blankets and 25.7% had used these interventions in the past (Green et al., 2006). In another study of parents' experiences using complementary treatments for children with autism, of those respondents who had tried sensory integration therapies, 86% saw improvements in communication, general behaviours, learning and sleep, whilst the remaining respondents reported either "no change" or "worse behaviour" (Şenel, 2010). In another study, Williams, Sears, and Allard (2006) undertook a survey of 202 parent perceptions of strategies used to facilitate sleep in children with autism. Forty

nine percent of respondents had tried wrapping their child in a blanket, of which 61% found this approach helpful as a strategy to promote sleep.

In a survey of ten parents, weighted vests were perceived as having either “worse” or “no effect” on a range of outcomes including language, tantrums, social skills, and self-help behaviours (Smith & Antolovich, 2000). In another study, James (2012) examined the treatment acceptability of weighted blankets following their use with three children with autism. Two mothers reported they would “somewhat recommend” and one would “not recommend” weighted blankets. In contrast, websites of commercial companies who supply weighted blankets (Mosaic Weighted Blankets., 2014; SensaCalm, 2014) include testimonials from parents who offer overwhelming support for the use of weighted blankets for sleep problems in children with autism and other developmental disabilities. It is however acknowledged these companies have a vested commercial interest in providing positive references.

Overall, the findings suggest that somatosensory approaches including weighted blankets are well received by many parents and practitioners. There are however those who are not satisfied with the benefits of such approaches. What is increasingly evident is the absence of a sound rationale for their use. Somatosensory interventions appear to be used in a haphazard approach by parents and professionals in the hope that they will be effective. Anecdotal reports suggest that compared to other approaches, weighted blankets provide a readily accessible and relatively easy intervention for children with sleep disturbance. It is likely that the ease of implementation, relatively low cost and immediacy of results are factors that contribute to the attractiveness of such approaches for parents.

Critique and summary of research on somatosensory therapies

Theoretical foundation. Questions and uncertainty remain about the theoretical foundation of sensory integration as a viable theoretical model on which to base somatosensory interventions. This, in part, is due to the theory of sensory integration remaining controversial and unsubstantiated. As previously discussed, few studies have examined the direct association between underlying brain functions and the behavioural outcomes, which form the basis of this theory. Furthermore, there is little in the way of controlled studies to support the theory of sensory integration, as most studies have failed to make this connection. Of the studies reviewed, only two incorporated a sensory integration framework into their rationale for the intervention approach (Davis et al., 2011; Myles et al., 2004). Nonetheless, the sensory integration model does provide an alternative perspective from which to view the impact of sensory experiences on behaviour. The sensory integration framework may also provide a rationale of sorts for the use of somatosensory therapies and the conditions under which the best outcomes may be achieved.

Research design. The majority of the research demonstrating the use of somatosensory therapies has been conducted using case studies and single case designs. Whilst case studies have high face validity for practitioners, their findings need to be interpreted with caution. For instance, case studies do not control for potential confounds such as changing medications, maturation and co-occurring treatments. This is a legitimate concern, given Green et al. (2006) found that on average, parents of children with autism report using several treatments in conjunction with one another. Similarly, Olson and Moulton (2004b) found weighted vests were often just one part of a much wider intervention plan. Three of the studies reviewed implemented multiple interventions simultaneously (Fertel-Daly et al., 2001; James,

2012; McClure & Holtz-Yotz, 1991) which means any improvement cannot be solely attributed one particular intervention.

Rigorous randomized controlled trials were utilised by three studies (Escalona et al., 2001; Field et al., 1997; Piravej et al., 2009). The random assignment of participants to groups and blinding of treatment conditions strengthens confidence in these findings. Despite this, criticism surrounds their methodological approaches including poorly defined target behaviours and inadequate description of intervention procedures. Hodgetts and Hodgetts (2007) also suggest the failure to report statistical results such as standard deviations and confidence intervals further weakens the findings (Escalona et al., 2001; Field et al., 1997).

Outcome measures. Somatosensory stimulation encompasses a wide range of therapies (i.e., weighted blankets and vests, massage, splints, hug machine and brushing) and likewise target a wide range of outcomes. Hodgetts and Hodgetts (2007) questioned the ability of somatosensory interventions to “successfully” target such a broad range of outcome measures which have included self-stimulatory and/or stereotypic behaviours (Deris et al., 2006; Escalona et al., 2001; Fertel-Daly et al., 2001; McClure & Holtz-Yotz, 1991; Zissermann, 1992) and distractibility and increased time on task (Escalona et al., 2001; Fertel-Daly et al., 2001; Field et al., 1997; Kane et al., 2004). Different outcome measures have also mean that direct comparisons between studies are difficult.

Research protocols. The varying and diverse research protocols demonstrating the use of somatosensory therapies are a significant limitation of the research within in this area. This is not surprising given the absence of a standardized approach to the use of somatosensory stimulation. In particular, there were noteworthy differences in the duration that weighted vests were worn. For instance

Kane et al. (2004) utilized the weighted vest for only 10 minutes, in contrast to another study where weighted vests were worn by participants for 2 hours (Fertel-Daly et al., 2001). James (2012) has questioned whether participants' exposure to weighted blankets for 30 minutes was sufficient in her own study. This concern can also be applied to other studies that implemented brief administration times (Hodgetts et al., 2011a; Myles et al., 2004). The optimal duration for wearing a weighted vest relative to producing behavioural change remains unknown, if there is indeed such a period.

Researchers also appear conflicted around when the benefits associated with wearing the weighted vest occur. The majority of studies purported the benefit of the vest occurs when the vest is worn. However, other studies suggest the benefits occur after the vest has been removed (Fertel-Daly et al., 2001; Myles et al., 2004). Fertel-Daly et al. (2001) followed Takagi's and Kobayasi's (1955, as cited in Fertel-Daly, et al., 2001) protocol based on findings from animal studies that indicate that deep pressure may create an initial surge in arousal before calming begins. Myles et al. (2004) cited Dunn's (1999) sensory integration framework as having informed the study's protocol whereby weighted blankets were introduced to reduce touch seeking behaviours prior to engaging in a task.

Summary. The New Zealand Autism Disorder Guideline's (Ministries of Health and Education, 2008) stance on sensory integration therapies is that there is insufficient evidence to make any recommendations with respect to the use of such approaches. The current review offers further support for this recommendation, particularly around the use of somatosensory therapies.

To date, only two studies have investigated the use of weighted blankets (James, 2012; Mullen et al., 2008) and of those only one has examined their use for children with autism (James, 2012). Other somatosensory therapies such as weighted

vests, massage, hug machines, and brushing have also been subject to a number of studies, but the findings have not been conclusive.

In summary, twenty-three studies demonstrating the use of somatosensory therapies have been reviewed. Of these studies, five reported positive findings, eight mixed findings and ten negative findings based on the criteria outlined by Lang et al. (2012). This review has also highlighted the need for these results to be interpreted with caution given the limitations and criticisms of the research methodologies. Nevertheless, these findings suggest that somatosensory therapies may be effective for some individuals. The application of well-designed and rigorous research studies are therefore required to provide clarity as to the effectiveness of these interventions and the conditions under which the best outcomes may be achieved. The importance of establishing an evidence base is highlighted given that weighted blankets appear to be a well-accepted practice and are commonly-used by parents (Şenel, 2010) and practitioners (Watling et al., 1999).

Behavioural interventions

Behavioural interventions have been shown to produce reliable changes in the treatment of sleep problems in typically developing children (Mindell, Kuhn, Lewin, Meltzer, & Sadeh, 2006). Behavioural interventions encompass a range of strategies including sleep hygiene principles, extinction, faded bedtime, stimulus fading, scheduled awakenings and less frequently, chronotherapy.

These same approaches have also been used successfully for children with developmental disabilities, including children with autism (Vriend, Corkum, Moon, & Smith, 2011). However, adjustments may be necessary for children with autism to make allowances for learning, language and health difficulties (Wiggs & France,

2000). These allowances may involve “graded changes” where new behaviours are broken down and taught in smaller, more manageable steps. There are several considerations regarding the suitability of the various behavioural strategies, however, the treatment selected should ultimately be based on the underlying sleep disorder and not the symptoms (Wiggs & France, 2000).

Theoretical framework of behavioural interventions

Behavioural interventions are heavily grounded in the principles of learning theory, specifically operant conditioning. Operant conditioning is built on the premise that most human behaviour is both learned and governed by its consequences (Skinner, 1953). Based on this principle, it is theorized that children are more likely to learn and maintain behaviours for which they receive positive reinforcement (e.g., parental attention). Similarly, children are less likely to maintain behaviours for which they receive no reward or reinforcement. The aim of behavioural interventions are to teach children new behaviours and increase the likelihood of them occurring through the use of positive reinforcement and/or reduce or eliminate inappropriate behaviours through the use of carefully planned contingencies or consequences.

Behavioural interventions may also be grounded in the principles of classical conditioning first proposed by Ivan Pavlov (Mazur, 2006). Classical conditioning is a learning process that occurs through associations between pairing an initially neutral stimulus (the conditioned stimulus) with an unconditioned stimulus, whereby the conditioned stimulus develops the capacity to elicit a conditioned response. In contrast to operant conditioning, behaviours conditioned via a classical conditioning procedure are not maintained by consequences.

Definitions and effectiveness of behavioural interventions

Two reviews have examined the effectiveness of behavioural interventions for sleep problems in children with autism (Schreck, 2001; Vriend et al., 2011). Six studies were discussed in the first review by Schreck (2001) which has since been extended by Vriend et al. (2011) with the inclusion of a further nine studies.

The review by Vriend et al. (2011) highlighted the need for caution when interpreting findings, making comparisons and drawing conclusions given the poor methodological rigour of the studies and the heterogeneity of the samples (e.g., symptom severity, intellectual ability and co-morbidities of participants) within and between studies. The practical limitations of research within this area also need to be considered, since interventions are adapted to the child's cognitive and developmental level. Thus the utility and ability to replicate the intervention becomes more complex and increasingly difficult (Vriend et al., 2011). With these thoughts in mind, the effectiveness of a range of behavioural techniques will now be reviewed.

Sleep hygiene Sleep hygiene is defined as a set of sleep-related behaviours that expose individuals to activities and cues that prepare them for and promote appropriately timed sleep (Jan et al., 2008). These behaviours may include implementing a bedtime routine, establishing a consistent schedule around sleep and wake times, ensuring appropriate levels of environmental stimuli (e.g., temperature, light and noise) and considering physiological factors that may impact on sleep (e.g., exercise levels and caffeine intake).

Those sleep hygiene principles selected may be required to be tailored to fit the needs of the individual child and family (Jan et al., 2008). For instance, children with autism typically respond well to routines but some children can become overly

fixated on the routine, which in itself may cause problems. Kodak and Piazza (2008) have suggested introducing small variations into bedtime routines to prevent them from becoming fixed as an unbreakable routine in the child's mind.

The mechanisms through which sleep hygiene promotes sleep are not completely understood but it is thought that sleep hygiene practices serve as an impetus for sleep onset. The principles of classical conditioning can be used to understand this mechanism in which a child is taught to associate a predictable sequence of cues with bedtime and sleep onset (Hill, 2011). It has also been suggested that sleep hygiene practices may increase the likelihood of entraining the individual's circadian rhythms to the 24-hour-cycle (Piazza, Fisher, & Sherer, 1997).

The implementation of sleep hygiene principles are considered most suitable where there are difficulties with sleep onset (Lancioni, O'Reilly, & Basili, 1999). There appears to be a general consensus that if poor sleep habits are not addressed, other sleep interventions are unlikely to be successful (Jan et al., 2008; Johnson, Giannotti, & Cortesi, 2009). Furthermore, Jan et al. (2008) suggests sleep hygiene practices should be considered a necessary but not sufficient component of sleep interventions.

In a review by Vriend et al. (2011), sleep hygiene practices were found to be routinely included as one component of a wider behavioural intervention. Despite this, only four studies have evaluated the effectiveness of sleep hygiene separately from other strategies (Christodulu & Durand, 2004; James, 2012; Piazza et al., 1997; Weiskop, Richdale, & Matthews, 2005).

Piazza et al. (1997) implemented regular sleep and wake times for two children with autism within a hospital setting. Minor improvements were reported in a

5-year-old child with delayed sleep onset and night waking. However, no changes were found in a 6-year-old child with early morning waking and night waking. More recently, James (2012) demonstrated the use of sleep hygiene principles in three children with autism who were experiencing delays in sleep onset. The intervention comprised education on sleep hygiene principles, and developing a plan for positive sleep habits including a 30 minute bedtime routine. Short-term improvements were found for two participants with delayed sleep onset but these improvements were not maintained at a 2 month follow-up. Improvements were also reported for the third participant, however, the sleep hygiene practices were implemented in conjunction with a stimulus fading and extinction procedure in which the participant's mother sat on a chair, gradually moving it further away from the child's bed whilst ignoring all demands. Therefore improvements cannot be attributed to the sleep hygiene principles alone.

In another study, Christodulu and Durand (2004) implemented a positive bedtime routine with a 3-year-old child with autism whose sleep difficulties were characterized by frequent night awakenings and difficulty with sleep onset including tantrums and getting out of bed. The intervention was abandoned after a few days as the parents found their child became too disruptive to carry out the procedures. Similarly, Weiskop et al. (2005) utilized a multiple baseline design across participants to demonstrate the use of sleep hygiene principles (i.e., quiet activities before bed and visual representation of bedtime routine) in six children with ASD aged between 3 to 7 years. The children were experiencing a range of sleep difficulties including bedtime disturbances, delayed sleep onset and co-sleeping. No improvements were reported for any of the children with the implementation of the sleep hygiene program

alone. These findings included data from an earlier study by Weiskop, Matthews, and Richdale (2001).

The limited research suggests that sleep hygiene does not appear to be sufficient as a strategy on its own to eliminate sleep problems in children with autism. Two studies reported mixed findings (James, 2012; Piazza et al., 1997) with Christodulu and Durand (2004) and Weiskop et al. (2005) finding no improvements to sleep problems following the implementation of sleep hygiene principles.

Difficulties implementing the sleep hygiene routines consistently over time have been identified as one factor that may impact on the effectiveness of the sleep hygiene practices (Christodulu & Durand, 2004; James, 2012; Weiskop et al., 2005). Despite this, the social validity of sleep hygiene programmes appears to be high. In the study by James (2012), all three parents indicated they would “strongly recommend” sleep hygiene principles to a friend. Similarly, in a survey of two hundred and two parent perceptions for strategies to facilitate sleep, Williams et al. (2006) found positive sleep practices such as regular bedtime (92%), darkened bedroom (76%) and bedtime story (76%) were among the common strategies used by parents.

Standard extinction Standard extinction refers to a traditional extinction process of systematic or planned ignoring. When implemented as a sleep intervention, this technique requires parents to ignore their child’s demands and tantrums from lights out at night until morning waking (Schreck, 2001). The only exception to this is for safety checks, or if the parent believes the child to be unwell.

Several studies have suggested that reinforcement contingencies such as parental attention or access to preferred activities may shape and maintain problem

behaviours associated with sleep (Didden, de Moor, & Curfs, 2004; Lancioni et al., 1999). In some cases negative reinforcement might also play a role in maintaining behaviours, particularly if those behaviours result in escape from aversive stimuli (e.g., going to bed or dark bedroom). It is likely the contingencies that maintain disruptive behaviours will vary between individuals. The goal of extinction therefore is to address the behavioural component of a sleep problem rather than focus on the underlying sleep physiology.

Three studies have examined standard extinction as an intervention for sleep-related problems in children with autism (Weiskop et al., 2001; Weiskop et al., 2005; Wolf, Risley, & Mees, 1963). In a single subject design, Wolf et al. (1963) implemented extinction and mild punishment (bedroom door closed) in an in-patient setting with a 3-year-old with ASD. Sleep problems (i.e., not sleeping and violent tantrums) were nearly eliminated and improvements were maintained at 6 month follow-up (Wolf et al., 1963). Similarly, Weiskop et al. (2001) demonstrated the use of an extinction programme in the home of a 5-year-old with autism. Improvements were reported in self-settling, co-sleeping and night-time disturbances. Following on from their earlier study, Weiskop et al. (2005) used a concurrent multiple baseline design, to implement a sleep hygiene programme prior to the implementation of an extinction programme in five children with ASD aged between 3 to 7 years. No improvements were reported with the sleep hygiene programme alone, however, following the implementation of the extinction programme Weiskop et al. (2005) reported improved sleep onset, elimination of co-sleeping and decreased bedtime disturbances. Improvements were maintained for all participants at 3 and 12 month follow-ups (Weiskop et al., 2001; Weiskop et al., 2005). Based on these findings, standard extinction meets the criteria established by Chambless and Hollon (1998) as

a possibly efficacious intervention in that improvements were seen in at least three participants in a methodologically sound study without conflicting evidence.

The attractiveness of standard extinction lies in its ability to produce effects within a reasonably short amount of time (Didden & Sigafos, 2001; Lancioni et al., 1999). For instance, one study reported that by the second night of the extinction programme, the child had accepted the new changes to bedtime routine (e.g., sleeping alone in own bed) (Weiskop et al., 2001). Moreover, Weiskop et al. (2001) found the social validity of this programme to be high. Whilst the parents were initially nervous about implementing the programme they strongly approved of the techniques upon completion of the intervention. Improvements in parents' self-confidence were also reported. Parents described feeling more confident around dealing with their child's other disruptive behaviours (Weiskop et al., 2001).

Despite the advantages associated with standard extinction procedures, the suitability and acceptability of the procedure is surrounded by controversy. Extinction procedures are often associated with a post extinction response burst (PERB) (Heron, Cooper, & Heward, 2007). The PERB is characterised by a sudden and temporary increase in negative behaviours followed by an eventual decline and then extinction in the behaviour. Parents must therefore be well informed about what to expect and the difficulties they may expect to encounter before commencing an extinction programme. Parents who may be unable to carry out the procedure must be provided with prior information that they may risk reinforcing the undesirable behaviours further if they are unable to follow through with the procedure. The renewal of parental attention intermittently reinforces the child's behaviour at a more intense level rendering it more resistant to change (France, Blampied, & Henderson, 2003).

Furthermore, the abrupt and total elimination of attention may cause distress to the child (Bramble, 1997; Vriend et al., 2011; Wiggs & France, 2000). Associated with this, parents may have to deal with emotionally charged situations that can raise uneasiness and moral doubts of leaving a child to “cry it out”. Extinction procedures are also likely to be perceived as a negative approach by family and friends.

Wiggs and France (2000) have also suggested extinction procedures may not be suitable for children with self-injurious behaviours and some physical illnesses (e.g., epilepsy or asthma). There are concerns for these children that disruptive behaviours might escalate to the point where the child may engage in self endangering behaviours or cause damage to the environment that cannot be ignored (Didden & Sigafos, 2001).

Graduated extinction is one of the modifications of standard extinction. Graduated extinction is an example of “graded changes” where parents do not attend to a child’s demands for progressively longer periods (Mindell, 1999). On successive nights the interval between attending to the child is increased a certain number of minutes until the target behaviours are no longer followed by parental attention. There is no clear evidence as to the optimum time intervals between checks or indeed whether a fixed or incremental regime is preferable (Hill, 2011). The goal of graduated extinction is to enable the child to develop “self-soothing” skills in order to fall asleep independently without undesirable sleep associations such as the requirement for parental presence (Mindell et al., 2006).

Two single-case studies have demonstrated the use of graduated extinction in children with ASD (Durand, Gernet-Dott, & Mapstone, 1996; Moore, 2004). Durand et al. (1996) implemented a gradual extinction programme and bedtime routine with two children aged 2 and 12-years-old with bedtime disturbances. Similarly, Moore

(2004) demonstrated the use of graduated extinction combined with a social story to eliminate co-sleeping and reduce sleep onset delays in a 4-year-old with autism with receptive language delays. Both studies reported reduced sleep onset delay (Durand et al., 1996; Moore, 2004). Improvements were also seen in reduced co-sleeping (Moore, 2004) and bedtime disturbances (Durand et al., 1996).

Despite these promising results, the lack of methodological rigour of these studies limits confidence in the findings. The multi-component design of both studies makes it difficult to attribute improvements to the graduated extinction component. Additionally, single case designs do not control for confounding variables, which in turn threatens the internal validity of the results. Similarly, the studies' design also limits the generalization of results to other populations.

Concerns have also been raised as to whether graduated extinction is subject to intermittent reinforcement through parental attention. Intermittent reinforcement increases resistance to extinction and may also increase the level and persistence of unwelcome behaviours. Consequently, it is possible that graduated extinction has the potential for extending the duration of crying before the time period of ignoring is long enough for extinction to occur. France and Blampied (2005) found infants treated with systematic ignoring with only minimal checking from parents cried more over the treatment period compared to the other programmes (e.g., systematic ignoring and systematic ignoring with parental presence). Whether this finding applies to children with autism is yet to be determined.

In spite of these limitations there appears to be strengths and weaknesses for both graduated extinction and standard extinction approaches. Standard extinction has however shown to be possibly efficacious (Chambless & Hollon, 1998) in helping

overcome sleep difficulties. In contrast, more rigorous research is needed before graduated extinction can be classified as a possible efficacious intervention.

Faded bedtime with or without response cost. Faded bedtime refers to an approach of determining a bedtime for a child where sleep onset occurs rapidly and then progressively moving this bedtime earlier until a desirable time is achieved. The initial setting of a relatively late bedtime is to increase the probability of rapid sleep onset, which in turn strengthens the association between bed and sleep. Thus faded bedtime techniques rely heavily on stimulus control as the main driver of change in behaviour.

Faded bedtime appears to be suitable for treating a range of sleep problems including settling difficulties, night waking and inappropriately timed sleep (Lancioni et al., 1999; Wiggs & France, 2000). One study has examined faded bedtime as an intervention for children with autism with sleep difficulties. In a single case design, DeLeon (2004) implemented a faded bedtime programme at an in-patient unit with a 4-year-old boy who displayed severe self-injurious behaviours associated with night waking. The original treatment bedtime was determined by calculating the average number of hours of disturbed sleep and moving back the bedtime by that number of hours relative to the target bedtime. Bedtime was gradually faded back at half-hour intervals and then 15 minute intervals until the target bedtime was achieved. The authors reported a reduction in night waking and post waking self-injurious behaviour (DeLeon, 2004).

A response cost may be added to the faded bedtime procedure in which the parent removes the child from bed if he or she does not fall asleep within a predetermined time (i.e., 15 minutes). The child is then kept awake for a predetermined length of time (i.e., 1 hour). The response cost is thought to serve two

purposes. It is expected to increase the probability of the individual attaining rapid sleep onset when returned to bed, which is purported to strengthen the association between bed and sleep. Secondly, it is expected that once the child has been removed and becomes increasingly tired, the removal from bed will serve as a negative consequence.

Four studies have demonstrated the use of faded bedtime with response cost (FBRC) (Christodulu & Durand, 2004; Durand, Christodulu, & Koegel, 2004; Moon, Corkum, & Smith, 2011; Piazza et al., 1997). Moon et al. (2011) demonstrated the use of FBRC and positive reinforcement in three children with ASD aged between 8 to 9 years. One week's baseline data collection was used to calculate a new bedtime 30 minutes later than the time a child typically fell asleep. If the child did not fall asleep within 20 minutes he or she was removed from bed and made to engage in a low intensity activity. The removal from bed was the response cost of the intervention. This procedure was repeated until the child fell asleep within 20 minutes of their new bedtime. Once the child fell asleep within 20 minutes for two consecutive nights, bedtime was moved 20 minutes earlier. This procedure was repeated until the child reached their target bedtime. Reduction in sleep onset latency was reported for all three children with ASD with improvements maintained at 12 week follow-up.

Studies by Christodulu and Durand (2004) and Durand et al. (2004) included a sleep restriction component in combination with faded bedtime. As part of a wider study, Christodulu and Durand (2004) utilized a sleep restriction and FBRC procedure with a 3-year-old boy with autism experiencing frequent night awakenings and bedtime disturbances (e.g., tantrums, getting out of bed and difficulty with sleep onset). New sleep schedules were calculated from baseline data collection using sleep diaries. The response cost component was to remove the child from bed and engage

the child in relaxing activity until he appeared tired. The authors reported that whilst the total sleep time decreased slightly, the number and duration of bedtime disturbances decreased. Similarly, Durand et al. (2004) reported a reduction in the frequency and duration of night waking in a 4-year-old girl with autism experiencing frequent night awakenings and bedtime disturbances (e.g., tantrums, crying, screaming and thrashing). In another study, FBRC saw a reduction in sleep disturbances in three children with autism aged 5 to 8 years (Piazza et al., 1997).

Despite promising results, faded bedtime with or without response cost does not meet Chambless and Hollon (1998) criteria for possibly efficacious intervention treatment. The lack of methodological rigour of the studies described using FBRC limits the confidence in the findings. The majority of studies were single case designs and whilst they are a practical alternative to more traditional designs there are a number of constraints to this approach. Single case design prohibits generalization of treatment effectiveness and, as mentioned previously, it does not control for confounding variables. Moreover, the use of different techniques within each of the studies makes replication of the studies difficult. The multi-component nature of the interventions used in the studies also means that changes cannot be solely attributed to the faded bedtime approach.

The question remains as to whether the effectiveness of faded bedtime is enhanced by the addition of the response cost. However, the literature remains unclear as to the extent that response cost component increases effectiveness of faded bedtime approaches. Furthermore, some parents may express difficulties associated with the response cost component of the intervention as it seems counter-intuitive to remove the child from bed as a consequence for not settling (Lancioni et al., 1999). This highlights the importance of parental education around implementing the various

components of the intervention so that parents understand the rationale behind the use of a response cost approach and use it with full comprehension of the associated difficulties.

Stimulus fading Stimulus fading refers to the approach of gradually moving a co-sleeper (e.g., parent) progressively farther away from the child's bed until the co-sleeper's presence is eliminated from the child's room at night (Didden & Sigafos, 2001; Schreck, 2001; Wiggs & France, 2000). The gradual distancing of the parent provides a gentle form of treatment and possible prevention of failure towards the goal of achieving fast and independent night settling (Lancioni & Smeets, 1986). The aim of stimulus fading is to teach the child to self-soothe at settling time in the absence of unwanted sleep-onset associations. Stimulus fading is particularly suitable when the main problems are settling to sleep and the need to eliminate parental presence or co-sleeping.

In a single case study, Howlin (1984) implemented a stimulus fading procedure for a 5-year-old boy with autism with difficulties initiating sleep onset, night waking and co-sleeping. After two nights the child settled within a few minutes and there were no efforts to return to the parent's bed. A reduction in night waking was also reported.

Stimulus fading techniques may be used alongside extinction procedures in which the parent ignores any demands of that child for attention or physical contact whilst gradually and incrementally increasing the distance between parent and child. Reed (2009) examined stimulus fading procedures in combination with other behavioural strategies (such as extinction, sleep hygiene and a reward programme) in 20 children with ASD with a range of sleep difficulties including difficulty with sleep onset, night waking, early morning waking and co-sleeping. Improvements were

reported in bedtime resistance, sleep onset delay, and sleep duration, although no significant improvements in night waking were found. A major limitation of the methodology of this study is that improvements cannot be attributed to specific individual components of the wider intervention.

Chronotherapy Less commonly used, chronotherapy involves systematically putting a child to bed at a progressively later time until the bedtime has been reset after having advanced it around the clock. This procedure is followed until the individual is going to bed and falling asleep at a desirable time. Piazza (1997) demonstrated the use of chronotherapy with an 8-year-old girl with autism and severe intellectual disability in an in-patient unit. Improvements included a reduction in sleep latency and night waking. An increase in total sleep time was also reported and all improvements were maintained at 4 month follow up (Piazza, 1997). Piazza (1997) concluded that chronotherapy may be useful for individuals who display irregular sleep-wake patterns and for whom other treatments have been unsuccessful. The use of chronotherapy is limited as it is complicated, intensive and requires constant monitoring. For these reasons the treatment acceptability of chronotherapy is low. Given only one single case study has demonstrated the use of chronotherapy for children with autism, additional research is needed before it can be considered possibly efficacious (Chambless & Hollon, 1998).

Summary of research on behavioural interventions

This review has highlighted the importance of identifying possible factors contributing to and maintaining sleep problems so that the most appropriate behavioural technique is selected. There are, however, some concerns regarding the

suitability of some techniques, particularly those associated with extinction procedures.

Despite limited research there is promising evidence for the use of behavioural interventions for sleep problems in children with autism. Although no studies have met the criteria for well-established or probably efficacious intervention, standard extinction has shown to be possibly efficacious as an intervention for sleep problems in children with autism (Chambless & Hollon, 1998). Additionally, other behavioural interventions such as graduated extinction, stimulus fading and faded bedtime have also shown promising results for children with ASD. The strong theoretical foundation from which behavioural interventions are based and their proven effectiveness when used for typically developing children offers further support for their use with children with autism. This review also highlights the need for future research not only on the effectiveness of behavioural interventions, but also the acceptability and suitability of these approaches for children with autism.

Rationale for the study and research questions

A review of the literature has shown that sleep problems in children with autism are common and the impact on child development and family functioning is of notable concern. Unsurprisingly, the amelioration of sleep problems has been found to result in a better quality of life for children and their families (Malow & McGew, 2008). Therefore, the identification of strategies which address sleep disturbances in children with autism is an area where achieving positive change for the child will have wide-ranging benefits.

This literature review has however identified the lack of evidence-based interventions for children with autism who experience sleep disturbances. There is

little evidence upon which to support the use of weighted blankets. In addition, the findings around the use of other somatosensory therapies is mixed. Confidence in these findings is also undermined due to methodological flaws and the criticisms surrounding the theoretical foundation underlying somatosensory therapies.

One way of strengthening the research within this area is to employ a more rigorous research design. A randomised control trial was beyond the scope of the current study, however multiple baseline designs prove a useful alternative when more rigorous designs are impossible. Multiple baseline designs avoid the ethical and practical constraints of reverting to pre-treatment levels to show treatment effectiveness (Kazdin, 2011). Instead the effectiveness of the intervention is demonstrated by replicating the phase changes (i.e., baseline to intervention) across at least two participants (Gravetter & Forzano, 2012).

Research aims. The primary aim of this study was to assess the effectiveness of weighted blankets as a sleep intervention for children with autism. The independent variable was the intervention method, the weighted blanket followed by a secondary behavioural intervention, if necessary. The dependent variables, sleep outcome measures were obtained by subjective (i.e., sleep diaries) and objective measures (i.e., actigraph). The use of two sleep outcome measures (i.e., sleep diaries and actigraph) were utilized to minimise the fundamental limitations of each method. Sleep diaries can only gather information on those behaviours that parents are aware of. For instance, quiet wakefulness without signalling by the child will be reported by parents as “sleep”. Therefore the actigraphy data provided unique data on underlying sleep states that was unable to be reported on by parents.

The specific mechanisms by which weighted blankets aid sleep are speculative. The study raised the question as to whether the weight of the blanket may

play a role in aiding sleep by reducing the movement of the child whilst he or she sleeps, hence inducing the behavioural quietude necessary for sleep onset. The actigraph was used to address this question.

It has also emerged from anecdotal reports that weighted blankets are only effective for some children. It is purported that individual sensory characteristics may differentiate those children for whom the weighted blanket is effective and those for whom gain no benefits. With this in mind, the Short Sensory Profile (SSP; Dunn, 1999) has been administered in the current study to examine this suggestion.

Based on anecdotal reports, weighted blankets appear to be well accepted by parents. The ease of implementation and immediacy of results are two factors believed to contribute to their acceptability. Regardless of the impressions of current acceptability, an examination of the social validity of an intervention is still critical for the purposes of this study. Firstly, there are ethical and legal concerns that children will be provided with humane and appropriate interventions from a social perspective. Secondly, if an intervention is not considered acceptable it is unlikely it will be used with integrity (Witt, Martens, & Elliott, 1984). For this reason the social validity of the weighted blanket from parents' perspectives has been examined using a modified version of Kazdin's Treatment Acceptability Questionnaire (1981).

Lastly, a behavioural intervention was offered to participants who did not respond to the weighted blanket. This aspect of the study was included to overcome ethical limitations associated with providing a non-evidenced based intervention. Additionally, whilst the research on behavioural interventions is promising, it too is limited. Therefore this aspect of the study will add to the existing current evidence base.

The specific research areas this study sought to examine were directed by the following questions:

1. Are weighted blankets an effective intervention for children with autism aged 7 to 13 years with sleep problems associated with sleep onset delay, night waking, sleep duration and co-sleeping?
2. If weighted blankets are an effective intervention what specific changes to underlying sleep states are evidenced on sleep efficiency, minutes awake, number of long wake episodes, sleep fragmentation index and increase in total sleep duration?
3. What effect if any, does the weight of the blanket have the on a child's movement during the night?
4. Does the sensory profile of children with autism aged 7 to 13 years old differentiate those that respond to the weighted blanket compared to those who do not respond?
5. What are parents' perceptions of the weighted blankets as an intervention for children with autism with sleep problems aged 7 to 13 years?
6. Are behavioural interventions effective for those children with autism aged 7 to 13 years who do not respond to the weighted blanket intervention?

Chapter 3

Method

Ethics and participant consent

Ethics Application and Approval. Ethics approval was sought and obtained from the Human Ethics Committee at the University of Canterbury before participant recruitment commenced (Appendix A).

Consent. All parents were required to give consent for their child to participate in the study (Appendix G). To ensure their child was informed as much as possible, assent was sought from children, as appropriate, in an age and developmentally appropriate manner (Appendix H). This included discussing each phase of the study and what this entailed (e.g., wearing the actigraph and sleeping with a weighted blanket).

Research Design

The study design has attempted to improve on some of the problems inherent in the previous research within this area, which is detailed in the literature review above. Specifically these improvements are: (1) the use of multiple baselines to rule out of suggestion that any changes are due to extraneous variables such as therapist contact, assessment procedures and medication factors; (2) attempting to replicate behaviour change across participants to demonstrate intervention effectiveness; (3) offering interventions sequentially so participants receive only one intervention at a time; (4) and to avoid the practical constraints of a planned reversal.

The non-concurrent multiple baseline used in this study was across five participants and four phases (*Baseline, Intervention 1, Intervention 2 and Follow-up*) (see Figure 1). These are detailed below:

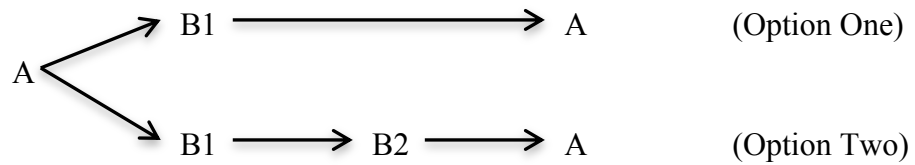
Baseline. Participants were randomly assigned to a pre-determined baseline of either 7, 10 or 14 days. Provided the baseline observations reached acceptable stability, observations were carried out for the stipulated length of time prior to moving to the intervention phase. Baseline data was used to gather information about the participants' existing sleep patterns prior to intervention. These observations provided a basis for making predictions of future performance. Kazdin's (1982) visual inspection procedures were used to assess stability and trends in the data.

Intervention 1. The baseline phase was followed by the first intervention phase. The intervention implemented during this phase was the weighted blanket. Despite suggestions that any effect from the weighted blanket would be almost immediate (R. Amour, personal communication, May 12, 2012) a fixed phase length of two weeks for the weighed blanket was selected for the study. This phase length allowed for a sufficient period of data collection to ensure stability of data; and to accommodate for possible delayed or cumulative effects of the intervention.

Intervention 2. At the end of Intervention 1, participants whose parents were not satisfied with the outcomes provided by the weighted blanket were offered a behavioural intervention. The behavioural intervention was undertaken during the next phase of the study (i.e., Intervention 2). The interventions during this phase were individualized depending on the nature of the sleep disturbance and the characteristics of the participant. The length of this phase varied depending on the type of intervention approach selected.

Follow-up. Eight-weeks post intervention, participants were invited to participate in the follow-up phase of the study. During this phase of the study, data was collected for 7 days assuming acceptable levels of stability were achieved. This signalled the completion of the data collection phase of the study.

Design Summary. For ease of understanding, Figure 1 differentiates the design for those who received the weighted blanket only (Option One) and those who received the weighted blanket and the behavioural intervention (Option Two).



- A = *Baseline:* Randomized baselines of 7, 10 or 14 days
- B1 = *Intervention 1:* Weighted blanked intervention
- B2 = *Intervention 2:* Behavioural intervention
- A = *Follow-up:* Eight-weeks post intervention

Figure 1. Outline of the phases of the Experiment

Participants

Recruitment. Participants were recruited from an advertisement placed in the Autism New Zealand Canterbury and West Coast Branch Quarterly E-Newsletters (Appendix B). Interested parents were invited to contact the researcher directly for additional information (Appendix C, D and E). During initial phone contact the researcher briefly screened parents to ensure their child’s suitability for participation in the study. No financial incentive was offered for participating in the study, however parents were invited to keep the weighted blanket and were to be provided with a summary of the research findings upon completion of the study. Participants were selected in order of presentation.

Inclusion/exclusion criteria. The initial inclusion/exclusion criteria for participants were (a) they were aged between 3 and 11 years; (b) they had received a formal diagnosis of autism; (c) their parent/s' report of the child's sleep problems confirmed that the sleep problems were not caused or exacerbated by a medical condition; (d) they were not co-sleeping with parents.

Safety reasons were a critical consideration in setting the lower age limit for participation in the study. Plastic pellets used to weight the blankets are considered a choking hazard to children under 3-years-old (SensaCalm, 2014). The upper age limit reflects the focus of the study, which is limited to children rather than adolescents or adults. There was however difficulty in the early stages of the study in finding sufficient numbers for recruitment, and for this reason this criterion was relaxed to include children up to the age of 13 years.

The criteria used in the identification and classification of sleep-related disturbances is not well agreed upon, within clinical or research contexts. For the purposes of this study, sleep-related problems were classified as such if they were identified as a problem by the parent. This is consistent with reports by Richdale and Schreck (2009) who suggested that if a parent believes that there is a sleep problem then investigation is warranted. Additionally, sleep problems that were caused or exacerbated by health conditions (e.g., asthma, epilepsy or sleep apnoea) were beyond the scope of this study and therefore not included.

Lastly, sleep difficulties associated with co-sleeping were initially excluded as it was considered unlikely that the primary intervention would resolve co-sleeping problems given the only change to be made during the primary intervention was the addition of the weighted blanket. This criterion was also relaxed to facilitate recruitment.

Participant characteristics. The participants were 5 boys aged between 7 years 4 months and 12 years 3 months of age. All participants had received a diagnosis of autism prior to beginning the study and were experiencing a range of parent reported sleep difficulties. A summary of participant characteristics can be found in Table 1.

With the exception of Hamish, all participants were taking melatonin at the time of the study. Andrew, Paul and Charles had all been prescribed melatonin by their physicians and took it on a daily basis as part of their bedtime routine. Oliver however had a medication regime whereby he took melatonin Monday through Thursday nights only, 5 to 10 minutes before going to bed. Melatonin is commonly used for children with autism and has been associated with improvements in a range of sleep parameters (Rossignol & Frye, 2011).

Table 1.

Summary of participant characteristics

Child	Age (Y-M)	Gender	Diagnosis	Sleep difficulties	Sleep related medication
Hamish	7-10	Male	Autism	Bedtime routine Delayed sleep onset Co-sleeping	None
Andrew	7-4	Male	Autism	Co-sleeping Night waking Early waking	Melatonin (2mg)
Oliver	11-5	Male	Autism	Co-sleeping Delayed sleep onset Night waking	Melatonin (3mg) (Mon-Thurs)
Charles	11-8	Male	Autism	Night waking Early waking	Melatonin (3mg)
Paul	12-3	Male	Autism	Bedtime routine Delayed sleep onset Night waking	Melatonin (6mg)

Setting

The study was conducted within each participant's home in the child's familiar sleep setting. The researcher conducted home visits prior to the beginning of each phase to provide the families with instructions and materials (e.g., sleep diaries, actigraph and weighted blanket).

Materials

Weighted Blankets. Weighted blankets are available in a range of different types, weights and sizes. Commercially available blankets recommend between 5% to 10% of an individual's body weight plus one kilogram (Mosaic Weighted Blankets., 2014; SensaCalm, 2014; Sensory Corner., 2006). Similarly, health professionals supporting the use of weighted blankets recommend using a formula of 10% of body weight plus one kilogram.

The weighted blankets used in this study were made specifically for the study by an Occupational Therapist who had consulted with colleagues as to the standard construction of the blankets. The blankets were made of a calico fabric with plastic pellets evenly distributed through the blanket to provide the weighted sensation. The pellets were securely contained within the calico covering. These materials were selected so that parents were able to wash the blankets. The dimensions of the blankets were the same for all participants (i.e., 153cm long and 92cm wide). The weight of the blankets varied in accordance with the formula above (i.e., 10% of body weight plus one kilogram).

There are currently no formal guidelines around the implementation of weighted blankets as an intervention for sleep problems. To ensure consistent, safe and responsible use of the weighted blankets by parents, the researcher developed guidelines for use (see Appendix F). These were based on recommendations from health professionals and advice from commercially available weighted blankets websites (Mosaic Weighted Blankets., 2014; SensaCalm, 2014).

Actigraph. Actigraphs are a commonly used objective measure of sleep as they can be used within the child's home environment. Actigraphs are movement

sensors that provide continuous monitoring of night-time limb movements in order to estimate sleep-wake cycles. They are small watch-like devices that are usually worn on the ankle or wrist depending on the child's preference.

The overall sensitivity of the actigraph to detect sleep ranges from 78% to 99% (Sitnick et al., 2008). However, the ability of the actigraph to detect sleep is greater than its ability to detect periods of quiet wakefulness. For example, a child lying in bed awake but with little movement may be incorrectly measured as being asleep. Additionally, actigraphs cannot distinguish between quiet wakefulness (reported by parents as "sleep") and wakefulness accompanied by signalling to parents. Furthermore, the actigraph is unable to record child and parent behaviours around settling and night waking. It is therefore recommended that actigraphs are used in conjunction with a second outcome measure such as sleep diaries.

The reliability of actigraph measurement of sleep has been demonstrated in previous studies. Actigraphs have been found to have reasonable reliability compared against polysomnography, a gold standard in sleep assessment (Sadeh, 2011). Furthermore, high correlations between actigraph and parental reports have been found on parameters such as sleep onset and sleep duration (Allik, Larsson, & Smedje, 2006; Goodlin-Jones et al., 2008). The reliability of actigraph records compared to the sleep diaries were not assessed in this study as the sleep diaries were used to indicate "bedtime" and "wake time".

The optimal actigraph brand for assessing sleep is unknown (Hodge et al., 2012). The Micro Motion-Logger Sleep Watch Actigraph (Ambulatory Monitoring Inc., Ardsley, NY) was utilized in this study. Consistent with other sleep research using an actigraph, data was digitised in 60-second epochs using the Zero Crossing Mode (ZCM). Zero Crossing Mode measures frequency of movement providing the

highest accuracy measure for sleep estimates. Actigraphs are paired with manufacturer-specific software that permit actigraph records to be downloaded to a computer and analysed in such a way that various aspects of sleep are quantified.

Measurement

Short Sensory Profile. The Short Sensory Profile (SSP) (Dunn, 1999) is a 38-item parent reported questionnaire on a 5-point Likert scale. Derived from a longer caregiver questionnaire, the SSP is accepted as the most appropriate version for research protocols (Dunn, 1999). It is designed to assess the behavioural responses of children aged 3-10 years to tactile, olfactory, gustatory, vestibular, auditory and visual stimuli. Scores of sensory processing are classified as either: a *definite difference* in which the score is 2 *SD* below the mean; having a *probable difference* whereby scores are between 1 and 2 *SD* below the mean; or having a *typical performance* in which scores are at or above 1 *SD* below the mean.

The reliability, internal consistency, and discriminate and content validity of SSP has been examined for individuals with and without disabilities. The reliability for the SSP was calculated using Cronbach's alpha, ranging from .70 to .90 and internal validity correlations for the SSP ranging from 0.25 to 0.76 (Dunn, 2005).

Actigraph. The sleep parameters measured by the actigraph were (a) sleep efficiency which is defined as the percentage of total time in bed (time between "lights out" and "get up"), time actually spent asleep, i.e., total time asleep/total time in bed x 100; (b) minutes awake, calculated as the total number of minutes spent awake between sleep onset and time of final waking; (c) number of long wake episodes, i.e., wake episodes that are longer than 5 minutes; (d) the sleep fragmentation index, which refers to the number of brief arousals experienced during

the night and is calculated as the number of night wakes divided by the total sleep time; (e) total sleep duration, i.e., the time in bed between “lights out” and “get up” actually spent asleep; and (f) an activity mean, calculated by the number of counts (frequency of movement) divided by the epoch (time interval used for activity sampling, i.e., 60 seconds).

Data was analysed using Action W-2 software (AMI) using scoring algorithms to identify sleep or wake states and to determine sleep parameters. There is currently no standardized procedure for selecting the optimal scoring algorithms. There is however evidence that suggests different algorithms are best suited for different ages (Hodge et al., 2012). Sadeh’s algorithm has been developed and validated amongst younger populations (Sadeh, Sharkey, & Carskadon, 1994) and was therefore was selected for use in this study.

Parent reported sleep diary. Parental reports are commonly used as the main source of information on children’s sleep in research and clinical contexts (Blampied, 2013). Sleep diaries offer unique information such as parental attempts to deal with sleep-related problem behaviours (Wiggs & Stores, 2004). In addition, the current study utilized sleep diaries (see Appendix J) to edit actigraph data for sleep and wake time and artefacts (e.g., sickness) and failures (e.g., technical problems) (Acebo et al., 1999).

The sleep parameters collected by the sleep diary included (a) information around bedtime routine (e.g., bedtime behaviours, co-sleeping, bedtime resistance, resistance going to sleep or going to sleep alone); (b) sleep onset delay; (c) sleep duration; (d) bedtime (pm); (e) wake time (am) and (f) information specific to the intervention (see Appendix G). The sleep diary used in this study was adapted from existing sleep diaries but simplified to promote parental compliance. The same sleep

diary was used across all phases of the study although questions specific to the intervention (i.e., weighted blanket or behavioural intervention) were incorporated during these phases.

Treatment acceptability and social validity

The social validity of the interventions was examined using the Treatment Evaluation Inventory (TEI). The TEI is a 15-item parent reported questionnaire on a 7-point Likert Scale that has been adapted by the researcher from Kazdin's Treatment Acceptability Questionnaire (1981). The TEI examined parental perceptions of acceptability, willingness to use, suitability, cruelty/unfairness, common sense, risk, side effects, effectiveness and improvements of the intervention.

Procedure

Initial semi-structured interview. Parents were invited to nominate a location for an initial semi-structured interview (i.e., Pukemanu/Dovedale Centre at the Health Sciences Centre, University of Canterbury or at their home). In all instances, participants' homes were selected for the interview location. Consent was gained from all participants prior to completing the initial interview. The interview was used to gather information about the sleep problems (e.g., nature, duration, severity, frequency and timing) that permitted a functional assessment to identify antecedents, consequences and factors that may have been contributing the maintenance of the sleep difficulties. Any relevant child/family factors that were pertinent to the study, and/or the administration of an intervention were also discussed.

Phase 1: Baseline data collection. Following the initial interview, participants were randomly assigned to a multiple baseline of 7, 10 or 14 days. Parents were asked to make no changes to their child's bedtime routine during this period. During the baseline period, parents completed sleep diaries every morning for the previous night's sleep. Participants were also asked to wear an actigraph for 7 consecutive nights to collect baseline information on a range of sleep parameters.

Phase 2: Weighted blanket intervention. The researcher met with parents to introduce the weighted blanket and discuss guidelines for use to ensure safety and appropriate implementation (see Appendix F). This included showing the child the blanket and ensuring the child could remove or reposition the blanket according to the his preferences. If there were any signs of distress, parents were advised to either abandon the blanket or attempt to re-introduce it again another night. The primary intervention took place over two weeks, during which time parents placed the weighted blanket over their child's body every night once they were in bed. Parents were instructed to place the blanket back on their child's bed if they noticed it had fallen off or when they returned their child to bed following a night waking. Parents were asked to make no other changes to bedtime routine other than the introduction of the weighted blanket.

For the duration of the intervention parents completed sleep diaries every morning for the previous night's sleep. In addition, participants were asked to wear the actigraph for 7 consecutive nights to enable any changes in movement as a result of the blanket to be examined. At the completion of the primary intervention parents were asked to complete the TEI (see Appendix I).

Phase 3: Behavioural intervention. Participants only progressed to Phase 3 if a discussion with parents and inspection of diary data indicated that the outcome of

the primary intervention (i.e., weighted blanket) was unsatisfactory and sleep difficulties persisted. For ease of following the data analysis, participants have been divided into two groups, those who progressed to a Phase 3, and those who did not, with an explanation surrounding this decision. The behavioural intervention was based on the functional assessment and case formulation that was completed in the initial interview. The researcher then met with the family to discuss the findings and the rationale for the behavioural intervention approach. Those approaches selected were based on well-established behavioural interventions representing best-practice in treating sleep difficulties in children.

The duration of the interventions varied depending on the approach selected (i.e., gradual or intensive) and the participants' responses. Parents were contacted by phone every day for the first seven days of the behavioural intervention to provide support and encouragement. At the end of seven days this was extended to once weekly phone contact to monitor progress. For the duration of this phase, parents completed sleep diaries every morning on the previous night's sleep and were asked to assist their child with wearing the actigraph during the probe session (i.e., 7 consecutive nights). The end of the second intervention occurred when parents indicated that they were satisfied by a resolution of their child's sleep-related problems.

Phase 4: Follow-up. Follow-up was scheduled for 8 weeks post-intervention. This period was extended for some families owing to practical problems. For those participants who did not receive a behavioural intervention but were identified as requiring further input, follow-up was completed before the participants received further intervention for their child's sleep disturbances. It was at the participants' discretion as to whether they continued to use the weighted blanket during this phase

of the study. Parents were asked to collect 7 nights actigraph recordings and sleep diary data during follow-up. This completed the data collection phase of the study.

Data analysis

Prior to analysis, the actigraph data was visually inspected to remove missing data and mark bedtime and wake times as indicated by the parent reported sleep diaries. Following data analysis, sleep outcome parameters from the sleep diaries and the actigraph were graphed across phases (i.e., Phases 1 to 4) and across participants using a conventional format for multiple-baseline data.

Improvements on sleep outcome measures assessed by the sleep diaries were evidenced by a decrease in sleep onset delay, a reduction in the number of wakes, an increase in total sleep duration and a reduction in co-sleeping. Consolidation in underlying sleep states was evidenced by increased sleep efficiency, reduction in minutes awake, reduction in number of long wake episodes, improvement in the sleep fragmentation index, increased minutes asleep and reduction in the activity index. Some participants may not have had difficulties within one or more of those areas, therefore no change would be evidenced.

Systematic visual inspection of graphed data was used to determine the intervention outcome, particularly focussing on changes in the magnitude (i.e., mean and level) of the variables across phases and the rates (i.e., slope and latency) of these changes (Kazdin, 1982).

Lastly, the social validity of the interventions was examined using the TEI. The questions were grouped into similar themes (i.e., acceptability, risk and side effects, and effectiveness) and examined.

Chapter 4

Results

The findings of the study are outlined in this chapter. Firstly, the quality of the data is reviewed, then the sensory profiles of the participants will be summarised. Following this, the sleep diary and actigraph data will be reported. Lastly, parent perceptions around the acceptability of the weighted blanket intervention will be summarised.

Quality of data

Participants had varying levels of compliance with their medication regimes throughout the study. Oliver did not take melatonin on night seventeen. Charles did not take melatonin during follow-up, specifically nights thirty-one through to thirty-seven. Paul did not take melatonin on nights six, seven, twelve, seventeen and on nights thirty through to thirty-five.

All participants completed the baseline phase of the study. With the exception of Hamish, all participants completed the weighted blanket phase of the study and adhered to the research protocol (i.e., placement of the weighted blanket once in bed). Hamish's parents reported he had an intense negative reaction to the introduction of the weighted blanket on the first night and consequently they did not attempt to use the weighted blanket again. Instead Hamish's parents chose to move directly onto the secondary behavioural intervention.

The quality of the data collected by the sleep diaries and actigraph across phases (baseline, weighted blanket intervention phase and follow-up) for participants is summarised below.

Sleep diary data. Sleep diary data was obtained across baseline, weighted blanket intervention and follow-up phases for four participants. Andrew supplied complete sleep diaries. No data was collected for Oliver on nights two, three and thirteen. Incomplete data was collected for Charles on night seventeen of the study. No data was collected for Paul on night twenty-three and his parents also failed to provide complete information on nights thirty-three and thirty-six around time of sleep onset. In addition, owing to family circumstances, the parents of Oliver and Charles did not provide sleep diaries for the follow-up phase of the study. Instead the parents of these two children were each asked to retrospectively report on their child's sleep over the previous seven nights.

Actigraph data. Andrew and Charles tolerated the actigraph during both baseline and intervention, however they both refused to wear them during follow-up. Andrew and Charles's parents forgot to use the equipment on nights twenty-one and twelve and thirteen, respectively. No data was collected for Paul or Oliver as they refused to wear the actigraph on their wrists, nor would they tolerate an alternative placement.

Sensory characteristics of participants

These SSP scores are shown in Table 3. Hamish demonstrated a *definite difference* (scores 2 *SDs* below the mean) in sensory processing on six areas on this measure. The only exception was for Sensation Seeking in which Hamish scored as

having a *probable difference* (scores 1 *SD* below the mean) with sensory processing. Hamish's Total Score indicates he experienced sensory processing problems.

Andrew had a *definite difference* as evidence by scores 2 *SDs* below the mean in four areas; Tactile Sensitivity; Movement Sensitivity; Under-responsiveness/Seeks Sensation; and Visual/Auditory Sensitivity. Andrew had a *probable difference* (scores 1 *SD* below the mean) on three areas, which are indicative of *questionable* sensory processing difficulties. Andrew's Total Score indicates he experienced sensory processing problems.

Oliver was determined to be experiencing *typical* sensory processing abilities for Taste/Smell Sensitivity and had *questionable* sensory processing difficulties (score 1 *SD* below the mean) on the Low Energy/Weak scale. Oliver had a *definite difference* on the remaining five areas. Oliver's Total Score was 2 *SDs* below the mean, indicating that he experienced sensory processing problems.

Charles was reported as having a *definite difference* (scores 2 *SDs* below the mean) in all areas of sensory processing on this measure. Charles's Total Score indicates that he experienced sensory processing problems.

Paul was reported as having a *definite difference* (scores 2 *SDs* below the mean) in all areas with the exception of Auditory Filtering, which was in the *typical* range (score of at or above 1 *SD* below the mean). Paul's Total Score indicates that he experienced sensory processing problems.

Sleep diary data

The sleep diary and actigraph sleep parameter scores are outlined in Tables 4 and 5, respectively.

Table 2.

Short Sensory Profile scores

Participant	Tactile sensitivity	Taste sensitivity	Movement sensitivity	Under responsiveness	Auditory sensitivity	Low energy	Visual sensitivity	Total Score
Hamish	12	4	4	25	12	11	7	75
Andrew	21	12	6	11	20	10	19	99
Oliver	24	16	9	12	14	25	15	115
Charles	16	4	5	18	12	11	11	77
Paul	17	5	6	16	23	13	11	91

Table 3.

Average (SD) sleep diary sleep parameter scores across phases

Participant	Number of days of data	Phase	Sleep Latency (minutes)	Total Sleep Duration (minutes)	Night Waking (minutes)
Andrew	10	Baseline	16.50 (4.74)	527.50 (23.48)	8.00 (2.74)
	14	Weighted Blanket	16.00 (4.01)	531.79 (43.31)	5.71 (1.89)
	7	Follow-up	15.00 (0.00)	540.00 (35.71)	7.50 (3.54)
Oliver	10	Baseline	62.50 (40.09)	540.00 (66.92)	6.00 (2.24)
	13	Weighted Blanket	61.07 (32.00)	550.00 (41.57)	13.75 (11.81)
	7	Follow-up	30.00 (0.00)	647.14 (29.28)	0.00 (0.00)
Charles	14	Baseline	11.50 (3.35)	594.86 (41.59)	7.02 (3.37)
	14	Weighted Blanket	9.00 (2.82)	594.86 (26.40)	6.33 (2.29)
	7	Follow-up	10.00 (0.00)	570.00 (0.00)	0.00 (0.00)
Paul	14	Baseline	59.50 (68.20)	542.31 (81.86)	33.22 (55.99)
	13	Weighted Blanket	49.15 (31.56)	491.02 (66.46)	45.71 (105.53)
	6	Follow-up	213.17 (102.40)	481.33 (50.70)	5.67 (3.06)

Table 4.

Average (SD) actigraph sleep parameter scores across phases

Participant	Number of days of data	Phase	Sleep Latency (minutes)	Total Sleep (minutes)	Long Wake Episodes	Sleep Efficiency	Activity Mean
Andrew	6	Baseline	13.50 (17.48)	554.50 (20.43)	8.50 (2.51)	77.54 (7.43)	33.53 (6.33)
	5	Weighted Blanket	19.60 (17.59)	538.80 (61.64)	6.80 (1.10)	82.54 (5.38)	28.44 (11.25)
Charles	5	Baseline	2.80 (4.38)	621.80 (57.15)	5.60 (2.97)	86.21 (6.72)	15.58 (5.09)
	6	Weighted Blanket	0.00 (0.00)	629.00 (0.00)	5.00 (2.28)	85.80 (2.56)	18.64 (6.21)

Sleep onset delay. Sleep onset delay data is presented in Figure 2. Normative mean sleep onset delay for a typically developing child Andrew's age is 21.8 minutes ($SD=23$) (Scholle et al., 2011). Based upon a comparison of normative levels Andrew's sleep onset delay at baseline fell within the normative range. During baseline he fell asleep after a delay of between 15 to 30 minutes ($M=17$, $SD=4.74$). This situation did not change when the intervention was introduced or at any other time during the intervention phase. This low level and relatively stable data trend was also observed during the follow-up.

Normative mean sleep onset delay for a typically developing child Oliver's age is 20.4 minutes ($SD=19.6$) (Scholle et al., 2011). Oliver's sleep onset delay was variable during baseline ranging between 5 to 160 minutes ($M=62.50$, $SD=40.09$). Based upon a comparison of normative levels, Oliver's sleep onset delay at baseline fell well outside this range indicating a sleep onset delay of clinical significance. There was no evidence of change following the intervention or at any time during the intervention phase where a similar pattern to baseline was observed. At follow-up, Oliver's sleep onset delay had stabilized as evidenced by a lower level and less variability in the data. Oliver was consistently falling asleep within 30-minutes during follow-up ($M=30.00$, $SD=0.00$).

Normative mean sleep onset delay for a typically developing child Charles's age is 20.4 minutes ($SD=19.6$) (Scholle et al., 2011). Based upon a comparison of normative levels Charles's sleep onset delay at baseline fell within the normative range. During baseline he fell asleep after a delay of between 5 to 20 minutes ($M=11.50$, $SD=3.45$) after going to bed. This situation did not change when the intervention was introduced or at any other time during the intervention phase. This same data trend was also observed during the follow-up phase.

Normative sleep onset delay for a typically developing child Paul's age is 20.4 minutes ($SD=19.6$) (Scholle et al., 2011). Paul's sleep onset delay during the baseline phase was between 20 to 330 minutes ($M=59.50$, $SD=68.20$). Based upon a comparison of normative levels, Paul's sleep onset delay at baseline fell well outside this range indicating a sleep onset delay of clinical significance. There was no evidence of change when the intervention was introduced or during the course of the intervention with the exception of a reduction in the last 5 days in the variability of the data points. This was reflected by his mean sleep onset delay decreasing over the phase by 10 minutes ($M=49.15$, $SD=31.56$) across the intervention phase compared to baseline. At follow-up there was a deterioration in Paul's sleep onset delay, which was characterized by increased variability of data points with no trend. Paul's sleep onset delay during follow-up was between 160 and 330 minutes ($M=213.17$, $SD=102.40$).

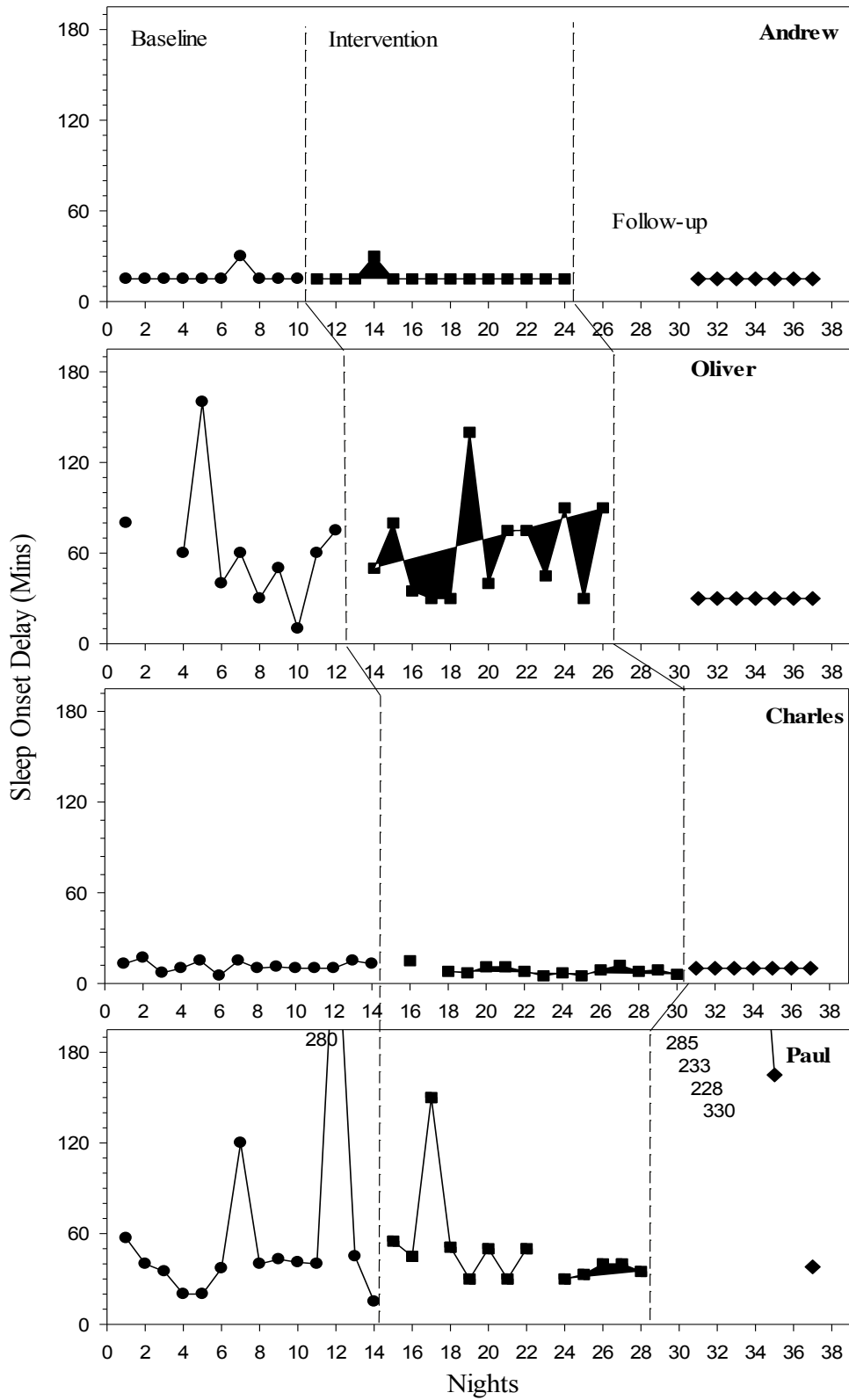


Figure 2. Parent report of sleep onset delay (SOD)

Number of wakes. The number of night wakes is illustrated in Figure 3. Andrew woke five nights out of ten during baseline. Over the intervention phase, Andrew woke seven out of the fourteen nights. There was no evidence of an intervention change when the weighted blanket was introduced except for a reduction, over the intervention phase in the number of nights on which he woke twice. This led to a decrease in variability. At follow-up Andrew woke two nights out of seven.

Oliver woke five nights out of ten during baseline. Oliver slept through for the last four nights of the baseline period. Night wakes were characterized by a single night wake. There was no evidence of change following intervention. Consistent with baseline, the same variability, trend and level of data was observed during the intervention phase. At follow-up, Oliver was sleeping through the night.

Charles woke one to two times every night during baseline. During the intervention phase a similar level and trend of night waking was observed. There was no evidence of an intervention effect when the intervention was introduced. There were, however no nights during intervention in which Charles woke twice. At follow-up Charles was sleeping through the night.

Paul woke eleven out of fourteen nights during baseline. During the second half of baseline there was a decreasing trend in the number of night wakes observed with fewer nights when he woke two to four times. There was no evidence of an intervention effect when the intervention was introduced, except for a slight reduction in the variability of the data points during the intervention phase. At follow-up, Paul's data showed a slight reduction in the variability of the data points compared to the baseline and intervention phases.

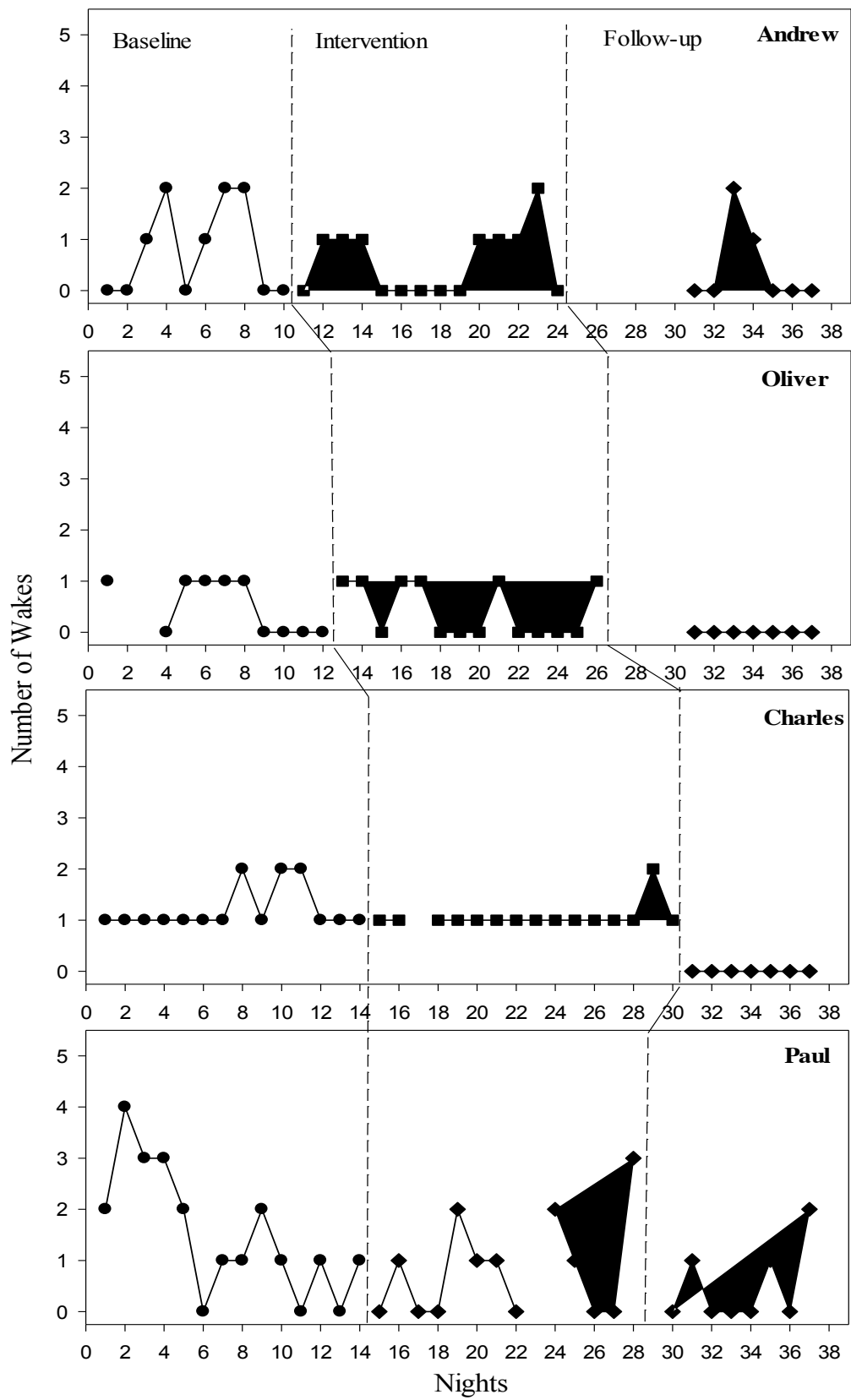


Figure 3. Parent report of night waking

Total sleep duration. Total sleep duration is shown in Figure 4. Normative mean total sleep duration for a typically developing child Andrew's age is 512.2 minutes ($SD=61$) (Scholle et al., 2011). Andrew's total sleep duration during baseline was between 485 to 580 minutes ($M=527.50$, $SD=23.48$). There was no evidence of an intervention change when the intervention was introduced or across the intervention phase. Similar patterns of variability were observed during the intervention phase. At follow-up, there was no change in the level, trend or variability in the data observed.

Normative total sleep duration for a typically developing child Oliver's age is 478.6 minutes ($SD=53.7$) (Scholle et al., 2011). Oliver's total sleep duration during baseline was between 400 to 620 minutes ($M=540$, $SD=66.92$). There was no evidence of an intervention change when the intervention was introduced. Nor were there changes in the pattern of the data with no trend observed during the intervention phase. At follow-up, Oliver's sleep duration had improved and he was sleeping between 640 to 670 minutes a night.

Normative mean total sleep duration for a typically developing child Charles's age is 478.6 minutes ($SD=53.7$) (Scholle et al., 2011). Charles's total sleep duration during baseline was between 540 to 660 minutes ($M=594.86$, $SD=41.59$). There was no evidence of an intervention change when the intervention was introduced or during the course of the intervention. Compared to baseline, the same level of data and variability of data points were observed during the intervention phase of the study. At follow-up, Charles's total sleep duration had improved and he was sleeping on average 570 minutes a night as evidenced by the flat line trend in the data.

Normative total sleep duration for a typically developing child Paul's age is 478.6 minutes ($SD=53.7$) (Scholle et al., 2011). Paul's total sleep duration during

baseline was between 540 to 640 minutes ($M=542.31$, $SD=88.86$). There was no evidence of a change when the intervention was introduced. At follow-up, Paul's total sleep duration had deteriorated ($M=481.33$, $SD=50.70$) which was evidenced by lower levels of the data, however, there was less variability in the data points. This indicates that Paul was getting on average less sleep compared to the baseline and intervention phase of the study.

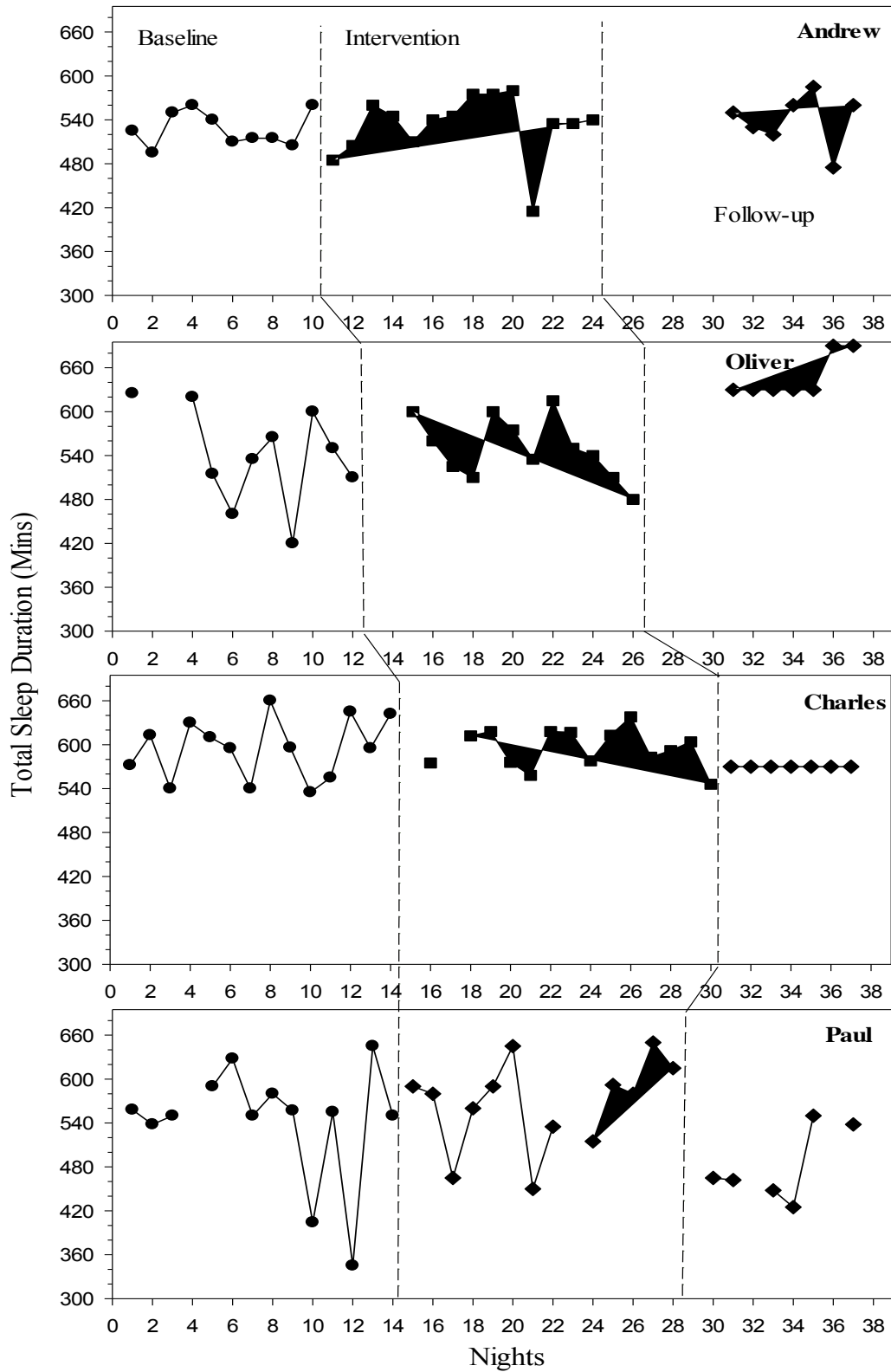


Figure 4. Parent reported total sleep duration

Co-sleeping. Co-sleeping data is shown in Table 6. Co-sleeping was identified as being a problem by the parents of two of the participants, Oliver and Charles.

Oliver co-slept with his mother on five out of ten nights during baseline. There was no evidence of a change when the intervention was introduced. Oliver co-slept with his mother six out of fourteen nights during the intervention phase. At follow-up, there was no co-sleeping reported. Oliver was falling asleep in his own bed and remaining there for the duration of the night.

Charles fell asleep every night in his parents’ presence during the baseline phase. He would also signal for their presence during night waking. There was no evidence of an intervention change when the intervention was introduced. Charles continued co-sleeping with his parents for the duration of the weighted blanket intervention. At follow-up, Charles’s co-sleeping difficulties had been resolved. Charles was able to fall asleep independently and was no longer signalling for his parents during the night.

Table 5.
Parent reported number of nights co-sleeping

	Baseline	Intervention	Follow-Up
Oliver	5/10	6/14	0/7
Charles	14/14	14/14	0/7

Actigraph data

Minutes awake. Total minutes awake is shown in Figure 5. On average Andrew spent 70 to 180 minutes each night awake. Baseline data was variable with no trend observed although there was a reduction in minutes awake over the last two nights. There was a decreasing trend in the number of minutes awake over the intervention probe session.

Charles spent on average 20 to 160 minutes awake each night during baseline. During baseline there was variability in the data points with a decreasing trend noted. There was less variability observed in the duration of minutes spent awake which decreased to between 60 to 100 minutes during the intervention probe session.

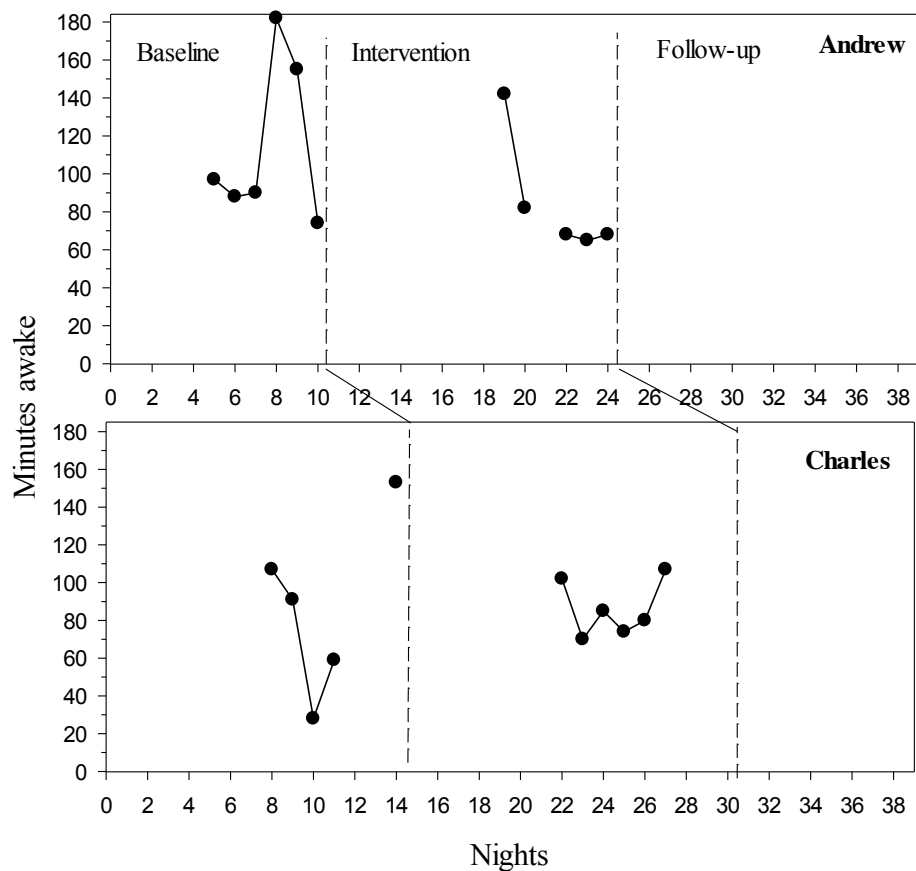


Figure 5. Actigraph data of minutes awake

Number of long wake episodes. The number of long wake episodes is illustrated in Figure 6. Andrew had between 6 and 12 long wake episodes a night during baseline. Less variability was observed during the intervention probe session with the number of long wake episodes decreasing to between 5 and 8 per night.

Charles had between one and nine long wake episodes a night during baseline. A similar pattern and variability of data points was observed during the intervention probe session, with between two and eight long wake episodes recorded per night.

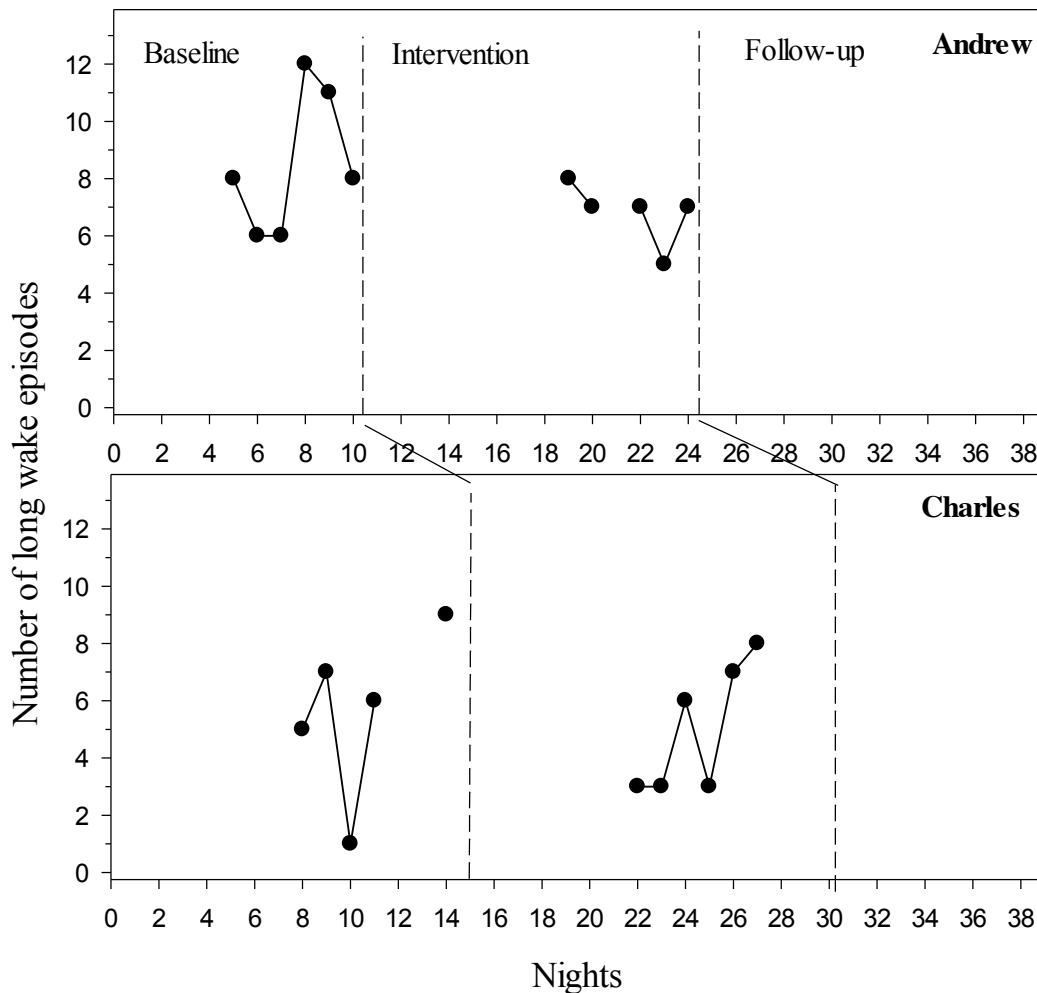


Figure 6. Actigraph data of number of long wake episodes

Minutes asleep. Minutes asleep is illustrated in Figure 7. Andrew spent between 330 to 450 minutes asleep each night during baseline. There was a similar pattern of variability with no trend observed during the intervention probe session.

Charles spent between 510 to 600 minutes asleep during baseline. A similar pattern was observed during the intervention phase probe session.

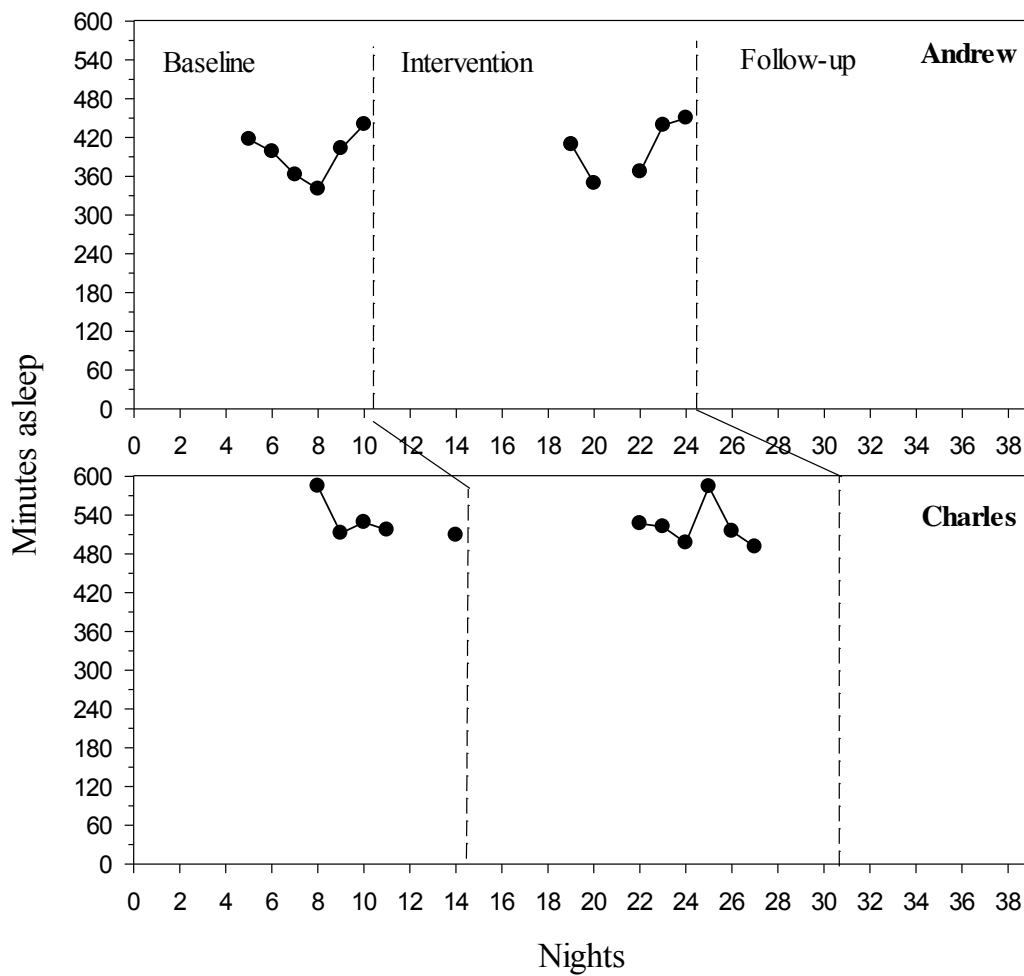


Figure 7. Actigraph data of minutes asleep

Sleep fragmentation index. The sleep fragmentation index is demonstrated in Figure 8. Andrew showed a decreasing trend during baseline. During the probe

session conducted over the intervention phase Andrew's sleep fragmentation was within the same range as that during baseline, however the data was more variable.

During baseline, Charles showed variability in data with no clear trend. A similar data pattern was noted during the probe session conducted over the intervention phase.

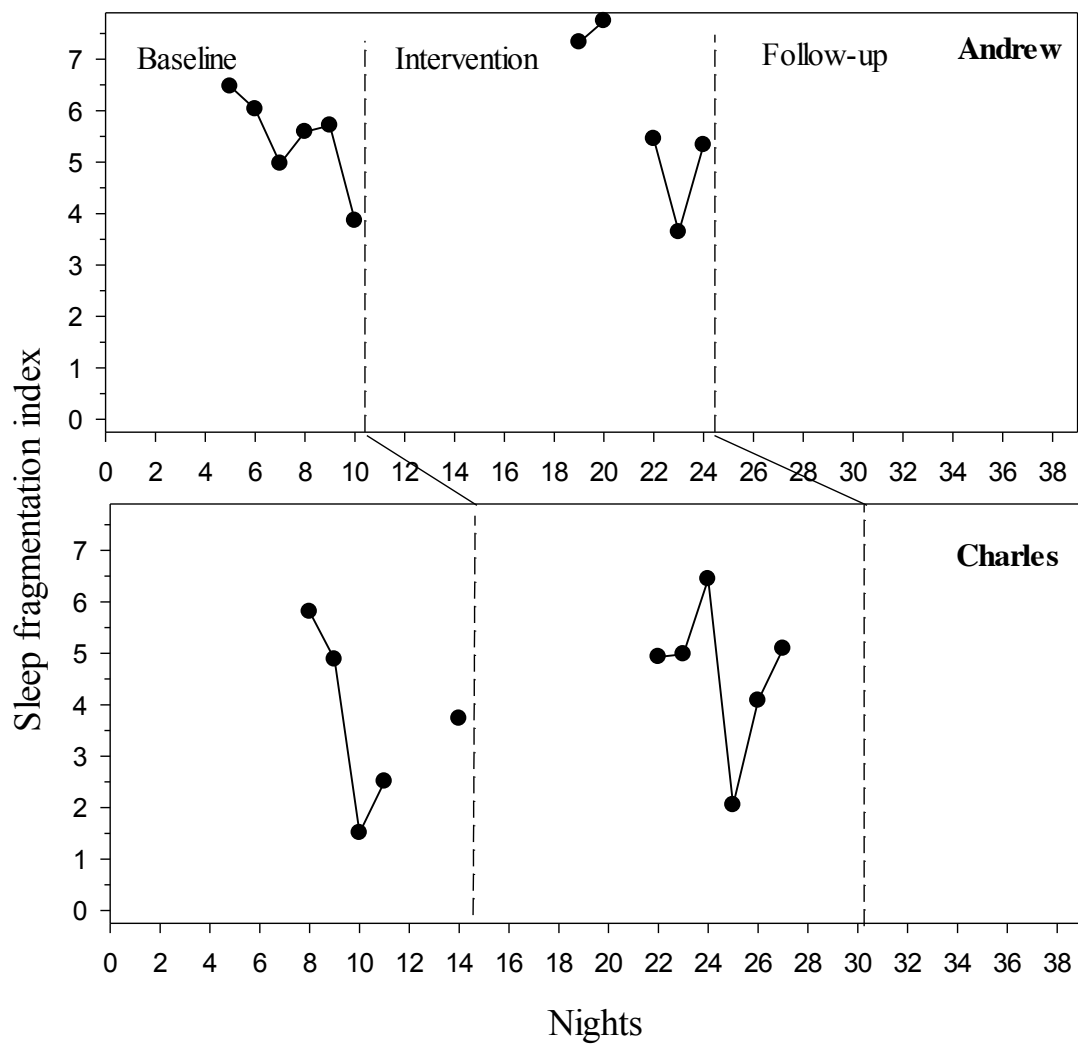


Figure 8. Actigraph data of sleep fragmentation index

Sleep efficiency. Sleep efficiency is illustrated in Figure 9. Normative mean sleep efficiency for a typically developing child Andrew's age is 94.8% ($SD=5.2$)

(Scholle et al., 2011). Andrew's sleep efficiency scores ranged between 65 to 85% during baseline. This suggests that some nights Andrew was awake for 35% of the night. There was however an increasing trend in sleep efficiency during the probe session over the intervention phase, which showed Andrew's percentage of sleep improving.

Normative sleep efficiency for a typically developing child Charles's age is 94.9% ($SD=5$) (Scholle et al., 2011). Charles's sleep efficiency scores during baseline ranged between 65 to 95%. Charles's sleep efficiency scores during the probe session over the intervention phase were consistent with that same pattern (i.e., level and variability) observed during the baseline phase probe session.

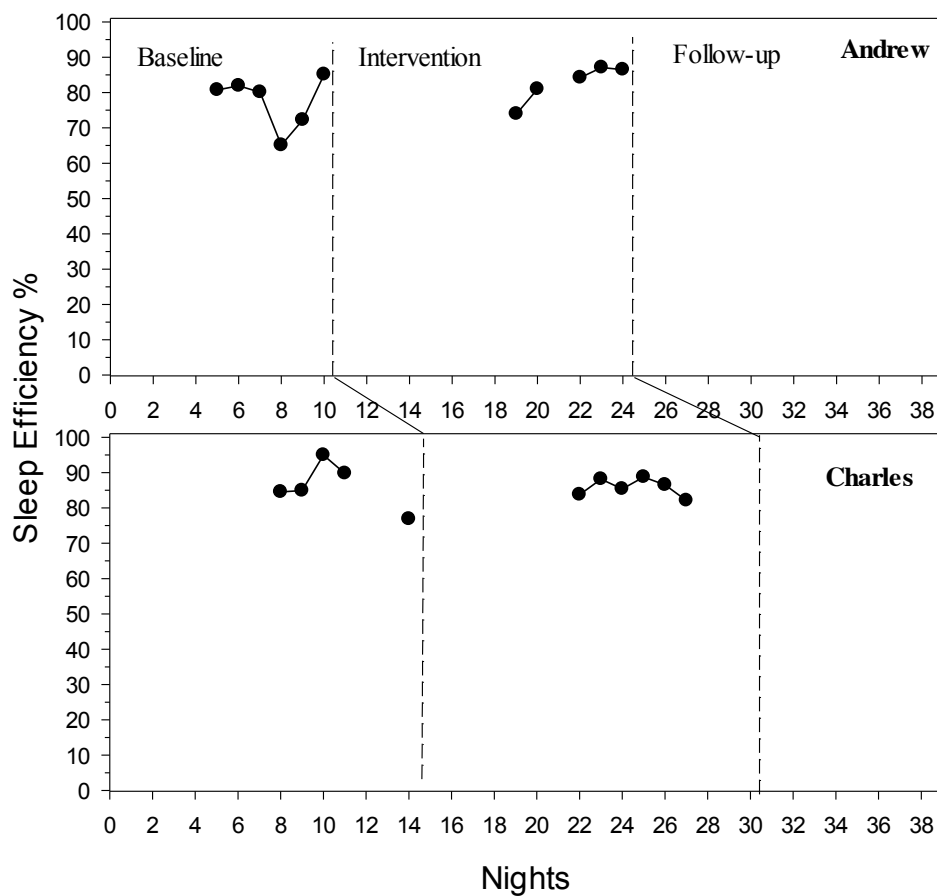


Figure 9. Actigraph data of sleep efficiency (%)

Activity mean. Activity mean is shown in Figure 10. Andrew's baseline data during the probe session showed no clear trend with his activity mean showing a range between 27 to 50. The variability in Andrew's activity mean increased during the intervention phase of the probe session, ranging between 15 and 50.

Charles's baseline data showed no clear pattern, ranging between 5 and 20 during the probe session. The variability of Charles's data during the intervention phase of the probe session showed his activity mean increasing to between 10 and 27.

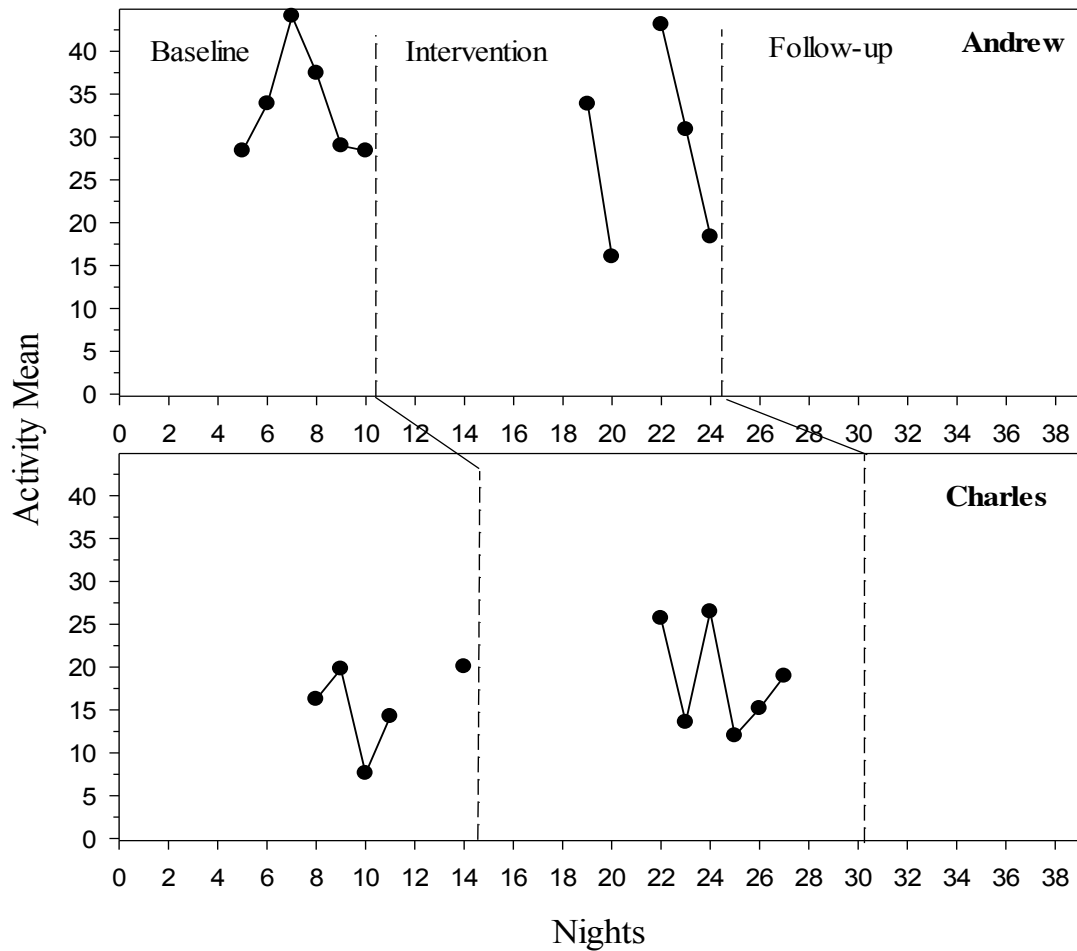


Figure 10. Actigraph data of activity mean

Summary across participants

Hamish rejected the weighted blanket intervention outright within minutes of the blanket being placed upon him. No data was returned for the intervention phase of the study and therefore his results have not been reported.

There was no evidence of an intervention effect following the implementation of the weighted blanket for Andrew on any of the dependent variables measured by the sleep diary, with the exception of night waking. Andrew displayed a reduction in the number of nights on which he woke twice during the intervention phase compared to baseline. There were however, a number of changes in sleep state variables measured by the actigraph. During the intervention probe session, there was a decrease in the number of minutes Andrew spent awake and a reduction in the number of long wake episodes, hence an increase in sleep efficiency. In addition, there was an increase in the variability of Andrew's activity mean over the intervention probe session which suggests he was moving more during this phase of the study compared to baseline. There were no other changes observed for total sleep duration or sleep fragmentation on this measure.

Oliver did not evidence any effect from the implementation of the intervention or during the course of the intervention on any of the dependent variables measured by the sleep diaries. At follow-up there was an elimination of night waking and co-sleeping and an increase in sleep duration.

Charles displayed a low level of sleep onset delay at baseline. This situation did not change when the intervention was introduced or at any other time during the intervention phase. Similarly, there were no changes observed in Charles's sleep duration or co-sleeping following the implementation of the weighted blanket

There was no evidence of an intervention effect following the implementation of the weighted blanket for Charles on any of the dependent variables measured by the sleep diary, with the exception of night waking. There was an elimination of two night wakes following the implementation of the weighted blanket. On the actigraph measures, two changes were observed during the intervention phase probe session. There was less variability in the duration of minutes spent awake and secondly, Charles's activity mean increased.

Paul showed improvements on a range of dependent variables measured by the sleep diaries over the course of the intervention, with the exception of total sleep duration. For sleep onset delay, there was a reduction in the variability of his data points during the intervention phase, which was reflected by a decrease in his average onset delay. Similarly, there was a slight reduction in the variability in night wakes during the intervention phase.

Behavioural intervention

Following the weighted blanket intervention all participants were identified as needing further intervention (i.e., progression to Phase 3), however as previously outlined not all progressed to Phase 3. Based on clinical assessment Oliver, Andrew and Paul received intervention from other agencies. Hamish and Charles both went on to receive further behavioural intervention designed by the author.

For Hamish, the functional assessment suggested that sleep onset occurred almost immediately after a family member joined him in bed. It was hypothesized that Hamish's sleep difficulties (i.e., delayed sleep onset and co-sleeping) were being maintained by family members joining him in bed late at night. A multi-component intervention was recommended comprising education around the importance of

positive sleep hygiene principles, provision of a faded bedtime programme and “camping out” (a form of the parental presence programme for older children; Sadeh, 1994) with planned ignoring and positive reinforcement. Hamish’s parents did not implement the recommended strategies. A change in family circumstances meant they withdrew from the study.

The functional assessment for Charles indicated that he had never learnt to fall asleep alone and lacked the necessary skills to self-soothe. It was hypothesised that his current sleep difficulties were being maintained by continued parental attention at both sleep onset and again during night waking. A multi-component intervention was recommended comprising “camping out” (Sadeh, 1994) with planned ignoring and positive reinforcement. Data for the behavioural intervention was lost by the family, so consequently cannot be presented. Anecdotal reports from parents indicated that they were able to follow the recommended behavioural intervention protocol with ease. They reported that by the fourth night Charles had started sleeping through the night and by the seventh night parental presence was no longer required for sleep onset.

Treatment Acceptability

Parents’ perceptions of the weighted blanket were examined using a modified version of Kazdin’s Treatment Evaluation Inventory (1981). Andrew’s mother had a general reaction to the weighted blanket that was “*very positive*” and she stated she “*very much liked*” the procedures in the intervention. She perceived the intervention to be “*moderately acceptable*” and believed the intervention to be “*moderately effective*”. She also reported that it was “*very likely*” that this intervention would result in permanent improvement in her child. Andrew’s mother did not perceive the

weighted blanket to cause any harm or discomfort, nor did she identify any undesirable side effects associated with the weighted blanket. Additionally, Andrew's mother did not identify any risks associated with the intervention and found it to be "*very humane*". Over the course of the intervention, Andrew's mother reported she was "*very willing*" to carry out the procedure and she had "*no anxiety*" about the intervention.

Oliver's mother had a general reaction to the weighted blanket that was "*positive*" and she stated she "*very much liked*" the procedures used in this intervention. She perceived the intervention to be "*very acceptable*" for Oliver's problems and believed the intervention to be "*moderately effective*". She also reported that it was "*moderately likely*" this intervention would result in a permanent improvement around Oliver's problems. Oliver's mother did not perceive the weighted blanket to cause any harm or discomfort, nor were there any undesirable side effects associated with the weighted blanket. She found the procedure treated Oliver in a "*very humane*" way. Additionally, she did not perceive there were any risks associated with the intervention. Over the course of the intervention, Oliver's mother reported she was "*very willing*" to carry out the procedure" and was "*not at all anxious*" about it.

Charles's mother had a general reaction to the weighted blanket that was "*positive*". She perceived the intervention to be "*moderately acceptable*" and believed the intervention to be "*moderately effective*". She also reported that it was "*moderately likely*" that this intervention would result in permanent improvements for Charles. Charles's mother did not perceive the weighted blanket to cause any harm or discomfort, nor were there any undesirable side effects associated with the weighted blanket. Over the course of the intervention, Charles's mother reported she was "*very*

willing” to carry out the procedure” however she was “*moderately anxious*” about carrying out the procedure.

Paul’s mother had a general reaction to the weighted blanket that was “*positive*” and she “*liked*” the procedures used in this intervention. She perceived the intervention to be “*moderately acceptable*” for Paul’s problems and believed the intervention to be “*moderately effective*”. She also reported that it was “*moderately likely*” this intervention would result in a permanent improvement around Paul’s problems. Paul’s mother did not perceive the weighted blanket as causing any harm or discomfort, nor were there any undesirable side effects associated with the weighted blanket and the procedure treated Paul in a “*very humane*” way. Additionally, she did not perceive there were any risks associated with the intervention. Over the course of the intervention, Paul’s mother reported she was “*very willing*” to carry out the procedure” but was “*a little anxious*” about it.

Chapter 5

Discussion

Research questions

The current study posed six research questions. The first was to examine the effectiveness of weighted blankets on the sleep problems of five children with autism aged 7 to 13 years. Secondly, the impact of the weighted blanket on the underlying sleep state organisation of these children was examined. Combined with this was the third question as to whether the weighted blanket had any influence on participants' movement during the night. The fourth research question examined if the baseline sensory characteristics of the participants differentiate those that respond to the weighted blanket, compared to those who do not respond. The fifth question was to examine whether parents perceived weighted blankets to be an acceptable intervention. Lastly, the study examined whether behavioural interventions are effective alternative interventions for children with autism who did not respond to a weighted blanket as an intervention for sleep problems. The results will be discussed with reference to each of these questions.

Effectiveness of weighted blanket intervention. One child (Hamish) rejected the blanket outright. Results from the sleep diary data for the remaining four participants indicated there was no sustained or substantial improvement in response to the weighted blanket intervention on any of the four outcome measures. These measures included sleep onset delay, frequent night waking, sleeping duration and frequent co-sleeping. Although no substantial improvements were identified a number

of minor and temporary changes in sleep onset delay and night waking were observed and are outlined below.

Sleep onset delay. Paul was identified as experiencing difficulties with delayed sleep onset during baseline. Following the implementation of the weighted blanket, a slight improvement in Paul's sleep onset delay was reflected by a reduction in variability during the last 5 days in the intervention phase. This improvement was not maintained at follow-up and did not satisfy his parents who continued to perceive his sleep onset delay as a problem. In addition, Paul's sleep onset delay remained well outside normative ranges for a child his age across all phases of the study (Scholle et al., 2011).

Night waking. A temporary improvement in night waking was observed for both Andrew and Charles during the intervention phase, compared to baseline.

Likewise, a temporary improvement was also observed for Paul, although his results indicated a spontaneous improvement during baseline with fewer nights when he woke two to four times during the second half of the phase. Therefore, Paul's results must be interpreted with caution. For all three participants, these temporary and minor improvements did not satisfy parental requirements as they all still perceived their child to have a sleep problem associated with night waking.

Overall, despite a number of minor changes observed in the sleep patterns of three participants these changes were not sustained across the weighted blanket intervention phase. These changes must also be interpreted with caution given the possibility of spontaneous improvement during baseline for at least one participant (Paul) and the variability in the data points across phases for all participants. If target behaviours are not stable when the intervention commenced the ability to draw

conclusions about the effectiveness of the intervention is compromised (Gravetter & Forzano, 2012).

The findings of the current study are consistent with the previous research on weighted blankets and other somatosensory therapies. In particular, James (2012) found no support for the use of weighted blankets as an aide to promoting sleep in children with autism who are experiencing a range of sleep difficulties. Similarly, support for other somatosensory intervention is weak.

An unexpected finding was the rejection of the weighted blanket by one participant. Hamish had an intense negative reaction to the weighted blanket almost immediately following the placement of the blanket on his body by his parents. The following is the parent's account of Hamish's response to the intervention, "*As soon as he was in bed with the weighted blanket in position on his bed, he yelled he couldn't breathe and went ballistic from 8.30pm till 10.00ish. He couldn't even cope with the blanket on his legs. His meltdown had him rolling on the floor, hitting his head, then he went into full on panic mode and couldn't breathe. Even when the blanket was removed it was like he thought it was still on him*". Following this reaction, Hamish's parents did not attempt to use the blanket again. Hamish's extreme reaction was surprising given no anecdotal reports from parents or practitioners have reported similar experiences.

Ayres and Tickle (1980) found hyper-reactive children with autism rejected the sensation of deep pressure input. Another study found behaviour deteriorated in three participants using weighted blankets (Kane et al., 2004). The findings of these two studies and the experience of Hamish suggests that not only do not all children benefit from the weighted blanket but they may also have adverse reactions to other somatosensory interventions.

Changes in underlying sleep states. Results from the actigraphy data indicated the weighted blanket intervention did not result in any substantial consolidation of underlying sleep states in the two children who tolerated this measure. There was however a number of minor changes observed which are outlined below.

Total minutes awake. Andrew demonstrated a decreasing trend in the number of minutes awake over the intervention probe session. Caution is recommended when interpreting this finding given that he also showed a reduction in total minutes awake in the final two nights during the baseline probe session. Minor changes were also observed for Charles. He demonstrated less variability in the total minutes spent awake during the intervention probe session compared to baseline.

Number of long wake episodes. Andrew had fewer long wake episodes per night during the intervention probe session compared to baseline. Despite this improvement Andrew was continuing to experience between five and eight long wake episodes.

Sleep efficiency. Andrew's sleep efficiency improved during the intervention probe session. It did however continue to fall short of normative sleep efficiency levels for a child his age.

Overall, there were no noteworthy changes in sleep consolidation outcome measures. Minor changes that were observed must also be interpreted with caution given the short duration of the probe session and the variability in the data. Furthermore, lack of follow-up data prevents the ability to draw conclusions as to whether these changes were temporary or maintained. Despite this, it remained clear that those changes that were observed did not satisfy parental requirements. All

parents continued to perceive their child as having difficulties associated with sleep at the conclusion of the weighted blanket intervention.

Impact of the weighted blanket on movement. The actigraphy probe sessions also examined whether the weighted blanket resulted in any changes to the participants' night-time movement. The current study found there was no substantial change on this measure for either participant although there were minor changes observed. For one participant (Andrew), there was an increase in the variability of movement during the weighted blanket probe session, which resulted in lower levels of movement on two nights during the intervention. This was reflected in a slight decrease in the average amount of movement during the intervention probe session compared to baseline. In contrast, there was a slight increase in the average amount of movement during the intervention phase compared to baseline for the second participant (Charles).

It was hypothesized that the weight of the blanket may suppress the movement of the participants, which in turn may promote the behavioural quietude necessary for sleep onset. The study did not confirm this suggestion.

Sensory characteristics. All five participants were identified as experiencing sensory processing problems on the SSP. In particular, they all displayed *under-responsiveness* which is characterised by exhibiting behaviours that create additional stimuli or seeking environments that provide additional stimuli. Hamish was the exception in this study and was the only participant who did not show sensation seeking characteristics on the SSP.

Anecdotal reports from health practitioners indicate that it is usual clinical practice to complete a sensory profile on participants before the implementation of a

weighted blanket. It is purported by practitioners that the weighted blanket is most effective for those individuals who are identified as having vestibular difficulties and problems with a heightened need for proprioceptive input. This is consistent with Dunn's (1999) suggestion that children who display *Sensation Seeking* behaviours will seek out the sensation of deep pressure input. Ayres and Tickle (1980) also found hypo-reactive children sought deep pressure input, although this same sensation was rejected by hyper-reactive children with autism.

The findings of the current study did not offer any support for suggestions that weighted blankets were effective for children with *Sensory Seeking* behaviours. Rather, it would appear that children with this sensory profile did not object to the intervention and accepted it with no substantial or sustained change.

Parents' perceptions of the weighted blanket intervention. Overall, parents' perceptions of the weighted blanket was positive. They perceived it to be an acceptable intervention for their child's sleep problems and considered it to be *moderately effective*. In addition, parents perceived no risk of harm or side effects as a result of implementing the intervention. The only exception to this was Hamish, whose parents did not complete this measure.

The finding appears to be in conflict with the actual benefits associated with the weight blanket. Previous research examining the therapeutic effects of weighted blankets has suggested that the perceived sense of benefit was greater than the actual benefit (Mullen et al., 2008). Similar findings were also reported by Krauss (1987) when demonstrating the use of the Hug Machine as an intervention for anxiety.

Effectiveness of secondary behavioural intervention. All participants were identified as requiring further intervention following the weighted blanket intervention. Although as previously discussed, only Hamish and Charles went on to receive a secondary behavioural intervention. Hamish withdrew from the study prior to implementing the behavioural intervention. Charles received a multi-component behavioural intervention comprising of “camping out” (Sadeh, 1994) with planned ignoring and positive reinforcement. This intervention resulted in the resolution of co-sleeping and night waking difficulties, with improvements maintained at follow-up. Charles’s parents reported they were very satisfied with the intervention. They found the intervention easy to implement with no distress caused to Charles and with rapid improvements. This finding, although based on a single case study, supports the use of individualised behavioural interventions that are based on a well formulated functional assessment of factors contributing to the sleep disturbance.

Factors impacting on the results

One factor that impacted on the results was the variation in the use of medication for the participants. All the participants were taking melatonin that had been prescribed by a paediatrician prior to undertaking the study. It was expected that the medication regimes of each participant would continue as usual through out the study. Despite the researcher requesting that all other night-time conditions for the participants remain unchanged, this was not achieved. When the sleep diary records were examined it was evident that individual levels of compliance of the use of melatonin varied widely throughout the study. This may have impacted on the ability to draw accurate and valid conclusions from the results. In particular, on some, but

not all of the nights that Paul did not take his melatonin, there was noticeable deterioration in his sleep.

Another factor that may have affected the validity of the actigraph data was the presence of a co-sleeper for one of the participants (Charles). Movement from a co-sleeper has been found to be detected by the actigraph (Sadeh et al., 1994; Tyron, 2004).

Limitations of the current study

One limitation of the study was parental difficulties in managing to complete the required number of sleep diaries. Consequently, there was missing or incomplete data for all but one of the participants. Furthermore, follow-up data had to be collected retrospectively for Oliver and Charles. A possible way to have improved parental compliance was for the researcher to have had daily contact with the parents throughout the study. The researcher could then have assisted by capturing some of the data progressively.

There were also limitations associated with the use of the actigraph. Actigraphs have been found to be well-accepted by children with autism (Sitnick et al., 2008). Surprisingly only two participants tolerated the measure in the current study and did so for only two of the three phases of the study. For those participants who resisted using the actigraph, attempts were made to make the actigraph acceptable to them using alternative placements (e.g., ankle or in pyjama pocket), but these attempts were also unacceptable to them.

In addition, the timing of the probe sessions meant that any immediate effect following the implementation of the weighted blanket from baseline to intervention could not be demonstrated. This limitation could be overcome in future studies by

ensuring the probe sessions are taken during the end of the baseline line phase and at the beginning of the intervention phase, or measuring throughout the duration of each phase.

The use of the SSP was also a limitation of the study. This was originally selected as the most appropriate measure of sensory profiles in research contexts. It was also the most suitable sensory measure for the age range of participants that were being recruited. However, due to initial difficulty recruiting participants, the age range was extended which meant that the ages of some of the participants were outside of that recommended for the SSP. So again caution is recommended when interpreting the scores and drawing conclusions.

The differences in the sleep characteristics of children with autism and typically developing children are well recognised. Due to the lack of normative sleep data for children with ASD, data based on typically developing children has been cited in the current study. The data was used to provide some indication of the clinical significance of the levels of sleep disturbance shown by the participants.

Recommendations for future research

Consistent with previous research, the current study did not find weighted blankets to be an effective aid in promoting sleep for children with autism. All parents still identified their child as experiencing sleep-related problems upon completion of the weighted blanket intervention. Despite this, the study yielded a finding that parent perceptions around the use of weighted blanket as an intervention for sleep problems were moderately effective.

This finding was consistent with two earlier studies which also suggested the perceived benefits to be greater than the actual benefits (Krauss, 1987; Mullen et al.,

2008). Therefore a possible avenue for further research is to attempt to better understand the factors leading parents to perceive a treatment as favourable in the face of poor results.

Future research is also warranted to better understand the characteristics of children who respond favourably to weighted blankets and those who do not, with a focused attention on the sensory characteristics of those children. This is important so as to ensure that children do not receive interventions that are adverse and distressing to them.

Clinical implications

The current study found that despite the weighted blanket not producing substantial improvements, sleep problems had resolved at follow-up without further intervention for one of the participants (Oliver). This was an unexpected finding as the literature suggests that sleep problems in children with autism are typically persistent in nature (Sivertsen et al., 2012).

The importance of understanding the sensory profiles of participants prior to receiving somatosensory interventions has been highlighted in this study. Whilst the evidence is tentative, there is some indication to support Ayres and Tickle's (1980) earlier finding that weighted blankets are unacceptable to children who do not display sensation seeking behaviours. There was however no evidence forthcoming from this study to support Dunn's (1999) suggestions and other numerous anecdotal reports that weighted blankets are effective for children with *Sensation Seeking* behaviours.

Conclusions

With the research questions in mind, four conclusions can be drawn from this current study. The first is that weighted blankets were not effective as an intervention for sleep problems in five children with autism aged 7 to 13 years. The second conclusion is that the weighted blankets appeared to have no substantial impact on the underlying sleep characteristics of those children including their night-time movement. Third, not all children responded favourably to weighted blankets, therefore it is important to differentiate those children from others to minimize the likelihood of providing a aversive and distressing intervention. Fourth, the perceived benefits of weighted blankets appear to be greater than the actual measured benefits and further investigation is warranted around this. Lastly, behavioural interventions that are individually tailored to the individual are suitable and effective in the resolution of sleep problems in children with autism and should continue to be the treatment of choice.

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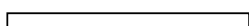
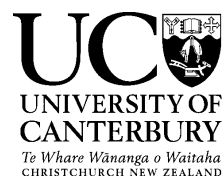
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Appendices

Appendix A. Letter of Ethics Approval



Ref: HEC 2012/133

19 September 2012

Jane Charleson
Health Sciences Centre
UNIVERSITY OF CANTERBURY

Dear Jane

The Human Ethics Committee advises that your research proposal “Effectiveness of weighted blankets as an intervention for sleep problems in children with autism” has been considered and approved.

Please note that this approval is subject to the incorporation of the amendments you have provided in your email of 12 September 2012.

Best wishes for your project.

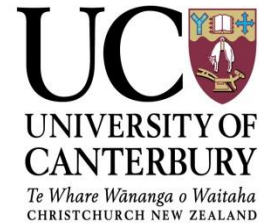
Yours sincerely

pp 

Lindsey MacDonald
Chair
University of Canterbury Human Ethics Committee

Appendix B. Advertisement

Does your child have autism and sleep problems?



A study is being conducted examining the effectiveness of weighted blankets as an intervention for sleep difficulties in children with autism

Children are eligible for the study if; (a) they are aged between 3 and 11 years, (b) they have received a formal diagnosis of autism (c) their parent/s reported sleep problems are not caused or exacerbated by a medical condition, and (d) they are not co-sleeping with their parents.

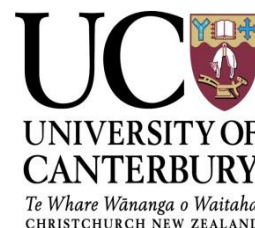
Potential benefit of participating is improved sleep quality for your child at no expense

The study is to be conducted as a requirement for the Master of Science in Child and Family Psychology by Jane Charleson. It has been reviewed and **approved** by the University of Canterbury Human Ethics Committee, Christchurch, New Zealand.

For further information please contact Jane on 021 297 1797, or alternatively by e-mail at jane.charleson@pg.canterbury.ac.nz.

Appendix C. Parent Information Sheet

Child and Family Psychology Programme Health Science Centre



Tel: +64 21 297 1797

Email: jane.charleson@pg.canterbury.ac.nz

Information Sheet

Dear Parents and Caregivers,

My name is Jane Charleson and I am studying towards a Master of Science in Child and Family Psychology at the University of Canterbury. My experience in working with children with autism and their families has contributed to my interest in pursuing research in improving sleep outcomes for children with autism.

This research project at the Canterbury University intends to examine the effectiveness of weighted blankets as an intervention for the treatment of sleep problems in children with autism. The project will also examine the effectiveness of behavioural interventions as an alternative treatment approach for children who have not responded to the first intervention (i.e., weighted blankets).

What are Weighted Blankets?

Weighted blankets are filled with rice, sand or plastic pellets to provide a weighted sensation. They are heavy enough to be calming and soothing but not so heavy as to be uncomfortable. The first intervention involves adding a weighted blanket to your child's existing bedding.



How might Weighted Blankets work?

Weighted blankets are not effective for every child but for some children they can be very effective in helping them relax and/or sleep by lowering their level of arousal.

Overview of the Study

Firstly, baseline information will be collected about your child's sleep for up to three weeks. Following this your child will receive the weighted blanket intervention for two weeks. Children whose parents are happy with their response to the weighted blanket (i.e. sleeping better) will receive no further treatment. Children who do not respond satisfactorily to the first treatment will be offered an individualized behavioural intervention. The choice of treatment depends on your child's sleep difficulties and will be negotiated with you. The duration of this study will vary depending on your child's needs and the treatment approach selected. Eight weeks following treatment you will be asked to collect follow-up sleep data over one week.

What will be required of you?

- You will be asked to attend an interview with the researcher that may take up to 90 minutes.
- For the duration of the study you will be asked to spend 5-10 minutes every morning completing a short sleep diary detailing your child's sleep for the previous night.
- Before beginning the first treatment the researcher will meet with you for 15-20 minutes to discuss the implementation of the weighted blanket which will require you placing the blanket on your child's bed each night for two weeks.
- If further treatment is requested (i.e., your child does not respond to first intervention), the researcher will meet with you again to discuss the implementation of a behavioural treatment. The time required of you and the duration of the intervention will vary depending of the needs of your child.
- Following your child's treatment you will be asked to complete a short questionnaire which will take approximately 10 minutes to complete.
- Any further information (e.g., medical details from your child's doctor) will only be obtained with your written consent.

What will be required of your child?

Your child will be asked to sleep with a weighted blanket at night.

Your child will be offered an individualized behavioural treatment should there be no improvements in their sleep following use of the weighted blanket.

Your child will also be asked to wear an actigraph, which is a small watch-like device commonly used to measure sleep in children with autism.



Confidentiality

Information collected will remain confidential, unless someone's safety is at risk. Data will be kept in a locked cabinet in a locked office. No identifying information will be used in the study so neither you nor your child will be able to be identified in any way. This information and data collected from the study will be held in a secure location for 5 years and then destroyed.

What will be done with data from the study?

The findings of the study will be available electronically from the University of Canterbury library and may also be published in professional journals. However, the anonymity of your information will be maintained. A summary of the findings will be given to you.

Potential benefit of participating is improved sleep quality for your child at no expense

Participation in this study is voluntary. You have the right to remove yourself and your child from the study at any time including any information that you have provided, without penalty.

The study is to be conducted as a requirement for the Master of Science in Child and Family Psychology. It has been reviewed and **approved** by the University of Canterbury Human Ethics Committee, Christchurch, New Zealand. If you have any

complaints about the study, please address them to The Chair, Human Ethics Committee, University of Canterbury, Private Bag 4800, Christchurch (human-ethics@canterbury.ac.nz).

For further information please contact me on 021 297 1797, or alternatively by e-mail at jane.charleson@pg.canterbury.ac.nz. My supervisor, Associate Professor Karyn France is a Clinical Psychologist with extensive experience working with children and families and can also be contacted via email on Karyn.France@canterbury.ac.nz. I look forward to receiving your response.

Sincerely,

Jane Charleson

Appendix D. Additional Information

Additional Information

Weighted Blankets

The weighted blankets used in this study will be individually tailored to the body weight of your child. Based on generally accepted principles and guidelines of commercially available blankets, the weight of the blanket is 10% plus one pound of your child's body weight. They will be made by Occupational Therapist, Annette Charleson.

The attractiveness of this treatment approach lies in the ease of implementation (Green, 2007). Weighted blankets are believed to decrease behavioural difficulties associated with sensory processing difficulties that are commonly reported in children with autism. They are thought to work by applying deep pressure input which stimulates the child's sense of where their body is in space and provides tactile sensation (i.e., touch experiences). This in turn aids in processing the sensory information which calms and lowers their state of arousal (Baranek, 2002; McClure & Holtz-Yotz, 1991).



Behavioural therapy

Standard behavioural treatments include structured bed-time routines such as establishing regular sleep and wake times. In addition, almost all behavioural approaches include some component of establishing a positive bedtime routine for the child. Positive bedtime routines include engaging in activities that promote sleep (bath, change into pyjama's, brush teeth, read books and turn off light). Those approaches mentioned above may also be used in conjunction with strategies whereby

parents are requested to ignore children's inappropriate demands at bedtime. There are several considerations regarding to the suitability of the various behavioural strategies, although the choice of treatment ultimately depends on the nature of the sleep problem (Wiggs & France, 2000).

Actigraphs

Actigraphs are a commonly used to measure sleep in children with autism in their home environment. They are watch-shaped devices that can be worn on either the wrist, ankle or sewn into pyjamas depending on your child's needs or preference. They are non-invasive and durable and have found to be well-accepted by children with autism (Sitnick et al., 2008).

Actigraphs monitor night time movements and then computer analysis is used to convert these movements into periods of sleep or wakefulness. The overall sensitivity of the actigraph to detect sleep ranges from 78% to 99% (Sitnick et al., 2008). However, despite its ability to measure periods of sleep and wakefulness the actigraph is unable to record child and parent behaviours around settling and night waking. For this reason the actigraph will be used in conjunction with parent reported sleep diaries.



Appendix E. Child Information Sheet

Child and Family Psychology Programme Health Science Centre



Tel: +64 21 297 1797

Email: jane.charleson@pg.canterbury.ac.nz

Information Sheet

(For the parent/caregiver to read to the child)

Jane is doing a study at University to help children who are having difficulties sleeping. She would like to work with us to help you sleep better at night.

What you will be asked to do?

1. You will be asked to try sleeping with a special blanket at night. You will use this special blanket along with your existing bedding so nothing else will change in your room.



2. If the special blanket does not help you sleep Jane will talk with us to decide on a different treatment to help improve your sleep.



3. During the study you will be asked to wear a special watch at night that will tell Jane how you are sleeping. We will talk to you about whether you want to wear it on your wrist, ankle or have it sewn into your pjs.



4. We will also be writing down how you sleeping are for Jane
5. Jane will call us during the study to see how you are sleeping
6. At the end of the study Jane will write up a report which is a type of story with all the information collected about your sleep. Other people will be able to read this report but will not know who you are.
7. This information collected during the study about your sleep will be kept secured and locked away until it will be destroyed in five years time.

If you have any further questions, Jane can be contacted on 021 297 1797, or alternatively by e-mail: jane.charleson@pg.canterbury.ac.nz. Jane's supervisor, Associate Professor Karyn France can also be contacted via email on Karyn.France@canterbury.ac.nz.

Sincerely,

Jane Charleson

Appendix F. Guidelines for Use

Weighted Blankets Guidelines for Use

Current practices of health professionals recommend using a standard formulation (10% of a child's body weight plus one pound) to determine the weight of the blanket. The weighted blanket you have been provided with has been tailored to suit your child using this recommendation.

Whilst there are recommendations around the weight of the blankets, there are currently no formal guidelines or protocols around the "use" of weighted blankets. Therefore the following guidelines have been prepared by the researcher from information provided by health professionals using weighted blankets within their practice.

Physical placement of weighted blanket

- The blanket must be able to be self-removed by your child at any stage during the night.
- The weighted blanket is to be used in conjunction with the usual bedding that your child has on the bed. The purpose of the weighted blanket is to provide the sensation of weight not warmth.
- It is recommended that the weighted blanket is either inserted into the existing duvet cover or alternatively be placed on top of existing bedding.
- The size of the blanket is designed to fit on top of your child's bed rather than hang over the sides.

Safety and use of weighted blanket

- The weighted blanket should never be used to restrain your child
- The weighted blanket should never be placed over your child's face
- Your child should never be wrapped in the weighted blanket
- The blanket has been individualized based on the body weight of your child and therefore should never be used on another child
- Your child should be able to self-remove the blanket or a parent should remove it immediately if a child shows signs of discomfort or distress.

- The blanket is to be used on the bed only and not used at any other time as a covering or wrap.

Non-acceptance of the weighted blanket

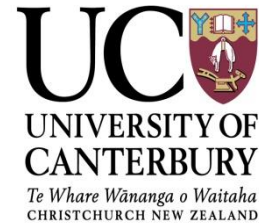
- Where your child resists the introduction of the blanket, several attempts over the following nights may be made to encourage them to accept the blanket. This may include using the weighted blanket for short periods initially and building up to acceptance.
- If a child persistently resists this must be honoured and parents are to cease the weighted blanket intervention.

Laundering and hygiene of weighted blankets

- The blanket's red outer cover is made of waterproof fabric which will prevent spills from penetrating the inner weighted blanket. Additionally, the red outer cover may be removed if necessary for washing or wiping down
- Do NOT wash the inner blanket with the weighted pockets as this will destroy the blanket

Appendix G. Parent Consent Form

Child and Family Psychology Programme
Health Science Centre



Tel: +64 21 297 1797

Email: jane.charleson@pg.canterbury.ac.nz

Parent Consent Form

Study Title: “Effectiveness of weighted blankets as an intervention for sleep problems in children with autism”

I have read and understood the description of the above-named study. On this basis I agree to participate in the study, and I also consent on behalf on my child.

I also consent to publication of the results of the study with the understanding that confidentiality will be preserved.

I understand that I may withdraw from the study at any time without any penalty. This includes the withdrawal of any information I have provided.

I note that the study has been reviewed **and approved** by the University of Canterbury Human Ethics Committee, Christchurch, New Zealand.

Name (Please Print):, Child’s Name,

Address.....

Telephone.....,

Mobile,

Email:.....,

Signature

Date:

Appendix H. Child Consent Form

Child and Family Psychology Programme Health Science Centre

Tel: +64 21 297 1797
Email: jane.charleson@pg.canterbury.ac.nz



Child Consent Form

Study Title: “Effectiveness of weighted blankets as an intervention for sleep problems in children with autism”

Jane and/or my parents have talked to me about the study and explained that:
(Please tick each box)

- This study is about helping me sleep better at night
- I know that I will be asked to wear a special watch that measures and records my sleep
- I know that my parents will be writing down how I am sleeping during the study
- The information collected about my sleep will be written up into a report which is like a story by Jane
- I know that only Jane and her teachers will see my information and that this information will be kept secured and locked away until it will be destroyed in five years time
- I know that other people will read the report but that my name will not be used so no one will know that I participated in the study
- I know that my parents have agreed for me to participate in the study
- I know that if I have any questions I can ask my parents or Jane
- I know that at any time I can refuse the special blanket, special watch and use of my information in the study
- I agree to be part of this study

Name, Date:

Parents Name Date:

Appendix I. Treatment Evaluation Inventory

Treatment Evaluation Inventory

Please complete the items listed below. The Items should be completed by placing a checkmark on the line over the statement that best indicates how you feel about the treatment. Please read the items very carefully because the checkmark accidentally placed on one space rather than another may not let us know your true feelings.

1. How acceptable did you find this treatment for your child's problem behaviour?

_____	_____	_____	_____	_____	_____	_____
not at all			moderately			very
acceptable			acceptable			acceptable

2. How willing were you to carry out this procedure?

_____	_____	_____	_____	_____	_____	_____
not at all			moderately			very
willing			willing			willing

3. How did you feel about the prospect of carrying this procedure out?

_____	_____	_____	_____	_____	_____	_____
very			moderately			not at all
anxious			anxious			anxious

4. How difficult did you perceive carrying out this procedure to be?

_____	_____	_____	_____	_____	_____	_____
very			moderately			not at all
difficult			difficult			difficult

5. How cruel or unfair did you find this treatment?

_____	_____	_____	_____	_____	_____	_____
very cruel			moderately			not at all
			cruel			cruel

6. How consistent was this treatment with common sense or everyday notions about what treatment should be?

_____	_____	_____	_____	_____	_____	_____
-------	-------	-------	-------	-------	-------	-------

very
difficult or
inconsistent

moderately
consistent

very
consistent
with
everyday
notions

7. To what extent did this procedure treat the child humanely?

not at all
humane

moderately
humane

8. To what extent do you think there were risks for your child in undergoing this kind of treatment?

lots of risks
were likely

some risks
were likely

9. How much did you like the procedures used in this treatment?

did not like
them at all

moderately
liked them

10. How effective was this treatment?

not
effective at
all

moderately
effective

11. How likely is this treatment to make permanent improvement in the child?

not at all
likely

moderately
likely

12. To what extent were there undesirable side effects as a result of this treatment?

many		some		no
undesirable		undesirable		undesirable
side effects		side effects		side effects

13. How much discomfort did the child experience during the course of treatment?

_____	_____	_____	_____	_____	_____	_____
very much			moderate			no
discomfort			discomfort			discomfort

14. How do you think this treatment affected your relationship with your child?

_____	_____	_____	_____	_____	_____	_____
very			no effect			very
negative						positive
effect						effect

15. Overall, what was your general reaction to this form of treatment?

_____	_____	_____	_____	_____	_____	_____
very			ambivalent			very
negative						positive

Appendix J. Sleep Diary

Sleep Diary

Name:

Study Phase: (Baseline/Weighted Blanket Intervention/Behavioural Intervention)

	___/___/___
Bed time routine	
Time your child was put to bed	
What did your child do while waiting to fall asleep	
What did you do while waiting for your child to fall asleep	
Sleep onset time	
Number of wakings during the night	
Time and duration of each night-waking	
What did your child do while trying to return to sleep	
What did you do while your child was trying to return to sleep	
Morning wake up time	
Number of daytime naps	
Time and duration of day time naps	
Weighted Blanket placement in the morning	

