A sensory intervention to improve sleep behaviours and sensory processing behaviours of children with sensory processing disorders

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Abstract

Purpose – This paper aims to investigate if a sensory intervention of moderate pressure touch of children with sensory processing disorder (SPD) affects sleep behaviours and sensory processing behaviours.

Design/methodology/approach – A total of 50 children, aged 5–11 years with both SPD and sleep difficulties in Israel, were randomly divided into an experimental and a control group, nonblinded. Participants in the experimental group received three weeks of nightly massage by their parents, with a baseline week on both ends. Parents filled out questionnaires reporting on sensory and sleep behaviours and filled out a nightly sleep log. Parents determined outcome goals using goal attainment scoring. The assessment tools used were the short sensory profile and the child sleep habits questionnaire (Dunn, 1999; Owens *et al.*, 2000).

Findings – Significant improvement was found in the total and subgroup scores of sleep participation measures including sleep onset, sleep anxiety, parasomnias, sleep duration, daytime sleepiness, as well as the total sleep score (F (1,48) = 24.71, $p < 0.001$).

Originality/value – Results of this study suggest that consistent application of moderate pressure touch as advised or trained by an occupational therapist may be used in clinical practice to improve sleep participation in children with SPD.

Keywords Occupational Therapy, Sensory processing, Moderate pressure touch, Sleep behaviours

Paper type Research paper

Sleep difficulties have been rising around the world. In the USA, reports of inadequate sleep among adults range from 31.2% in 2003, to 41.9% in 2012, showing a marked increase (Singh and Kenney, 2013). The prevalence of sleep disorders in Israel has been found to be similar to that of other Western countries (Fund *et al.*, 2020). Sleep disorders affect between 11% and 37% of typically developing school aged children, causing a myriad of problems including daytime fatigue and decreased gross motor abilities (Galland *et al.*, 2012; Vasak *et al.*, 2015; Owens *et al.*, 2000; Spruyt, 2020). Children with special needs diagnoses such as autism spectrum disorders (ASD) have an even greater reported prevalence of sleep difficulties, ranging from 40% to 80% (Cortesi *et al.*, 2010; Krakowiak *et al.*, 2008; Richdale and Schreck, 2009).

According to the literature, pediatric sleep difficulties may be divided into two functional categories, physical breathing disorders and behavioural sleep difficulties. The category of physical breathing disorders includes apnea and difficulty breathing. The category of sleep behaviours includes sleep latency (difficulty falling asleep), wake time after sleep onset, total sleep time and night terrors, also known as parasomnias (Chokroverty, 2010; Sleepnet.com, 2011). Owing to the negative occupational implications of sleep disruption, the domain of rest and sleep was added to the Occupational Therapy Practice Framework in 2008, as one of eight domains of intervention (American Occupational Therapy Association, AOTA). The domain of rest and sleep is further divided into three subcategories: rest, sleep preparation and sleep participation. The AOTA (2017) states that sleep interventions provide a foundation for individuals to participate in valued occupations, a core concept found in occupational science literature (Taylor, 2017). AOTA identifies a need for adding further studies to the base of evidence for occupation-centered sleep interventions. Leland *et al.* (2014) concur, stating that occupational therapy (OT) intervention can target the "context and environment, performance patterns" and sleep hygiene routines . Milton and Lovett (2014) suggest sensory-based strategies to promote calm sleep which include nighttime routines, provision of sensory input and

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reduction of sensory stimulation at bedtime. Tester and Foss (2018) concur that increasing research efforts for sleep and sleep assessment will improve the quality of life for clients.

Sensory processing may be defined as the way that the nervous system receives sensory input and turns them into responses (Miller, 2006). Problems in sensory processing have been noted in difficulty with behaviour, socialization, self-regulation and motor function (O'Donnell *et al.*, 2012). The relationship between sensory processing and sleep in typically developing children has been investigated in a number of studies. In total 16% of parents of school children aged 7–11 years reported tactile or auditory sensitivity (Ben-Sasson *et al.*, 2009). Tactile sensitivity was noted to be a significant predictor for sleep difficulties in children aged 6–10 (Shochat *et al.*, 2009). Similarly, typically developing infants and toddlers, aged 1– 3 years with increased sensitivity were found to need more time to settle to sleep (Vasak, 2015). Foitzik and Brown (2018) reported correlative and predictive relationships between a variety of sleep and sensory subsets in typically developing school children aged 8–11 years. One finding revealed that sleep duration was correlated with touch ($r = 0.33$, $p < 0.05$) and that the subcategories of social participation and taste and smell together accounted for 25% of the total variance F (2.42) = 7.01, adjusted $R^2 = 0.21$, $p < 0.05$).

The relationship between sensory processing and sleep has been investigated in children with various impeding conditions. Children with fetal alcohol syndrome were found to have shortened sleep duration, increased night awakenings and increased bedtime resistance (Wengle *et al.*, 2011). Children with ASD also had a greater prevalence of sleep disturbances than their typically developing peers (Reynolds *et al.*, 2012). Children with atopic dermatitis who had sensory hypersensitivity were significantly correlated with lower sleep quality, including sleep anxiety and parasomnias. The authors suggested a mechanism of hyperarousability that might account for the sensory sensitivity and the disturbance in the sleep patterns (Shani-Adir *et al.*, 2009).

A limited amount of literature regarding OT intervention is found for the adult population, and no intervention literature to improve sleep was found for the pediatric population. A randomized controlled study compared the effectiveness of three OT sleep interventions for adults using either a sleep pillow, meditation or a sleep hygiene regimen (Gutman *et al.*, 2017). The authors found significantly fewer nighttime awakenings with the pillow usage and concluded that the study provided support for sleep intervention by occupational therapists. A systematic review of sleep interventions was performed for the geriatric population with 13 studies of rigor identified with varying results (Smallfield and Molitor, 2018).

The research literature on OT interventions for sleep in the pediatric population is limited. Leland *et al.* (2016) state there is a paucity of evidence that investigates sleep interventions in children, especially interventions that are occupation-based. The literature that is found regarding the prevalence of sleep difficulties in children with sensory processing disorder (SPD) is primarily found with comorbid conditions such as ASD. To date, literature has mainly focused on describing prevalence of sleep difficulties in the typical pediatric population (Ben-Sasson, 2009; Shochat *et al.*, 2009; Foizik *et al.*, 2018; Vasak *et al.*, 2015) and in atypical populations (Shani-Adir *et al.*, 2009; Reynolds *et al.*, 2012; Wengle *et al.*, 2011). In a 2020 updated systematic review of the efficacy of OT interventions, Weaver (2015, p. 8) found that "despite the prevalence of sleep problems and their deleterious effects, efficacy studies supporting OT interventions for sleep or rest in people with ASD have not yet been published." This finding further supports the need for additional intervention studies in OT regarding the domain of rest and sleep.

The use of moderate pressure touch, also referred to as massage, has been found to be effective in children with self-regulation difficulties such as ASD. Moderate pressure massage was found to have a calming and regulating effect on preterm babies and resulted in improvements in the child's play skills when administered over a 3–7-week period of time (Hendel, 2017). Children aged 5–6 years with ASD who received Qigong massage improved in the resolution of tactile impairment and demonstrated improvement of social skills, language and behaviour (Silva *et al.*, 2016). Improvement in children with ASD who received parental massage for a month was noted to have decreased hyperactivity and impulsivity and improved on-task behaviours. The changes were attributed to improvement in sleep following the massage application (Escalona *et al.*, 2001). Limited literature was available for the effect of massage on children with SPD without associated comorbid diagnoses until this study.

Therefore, the purpose of this study was to investigate if there was a causal relationship in children with sensory processing difficulties without additional comorbidities between the provision of sensory inputs and outcomes of behavioural sleep parameters. We hypothesized that children aged 5–11 would demonstrate improved sleep following a period of parental application of moderate pressure massage. This is one of the first intervention studies for children with sensory processing difficulties for improving sleep in children with SPD.

Method

Research design

The study used a pretest and posttest prospective experimental design with nonblinded randomized assignment to a control or intervention group, using a convenience sampling method for recruitment. This study was approved by the Nova Southeastern University's clinical ethics review board.

Participants

The study was comprised of children with sensory processing difficulty between the ages of 5.0 and 11.11 years old who had concurrent behavioural sleep difficulties. Parents were recruited through convenience sampling methods in a developmental center in Modi'in Elite in Israel. Parents completed the short sensory profile (SSP) questionnaire for sensory difficulties and the child sleep habits questionnaire (CSHQ). Children whose scores on both questionnaires indicated significant difficulty were deemed eligible for inclusion in the study. Children were excluded from the study if they had comorbid diagnoses of ASD, intellectual disabilities or psychiatric disorders.

Children with attention deficit hyperactivity disorder (ADHD) were accepted into the study owing to the high clinical prevalence of comorbidity of ADHD with SPD. The experimental group had two children diagnosed with ADHD and four whose parents suspected ADHD. The control group had one child diagnosed with ADHD and two whose parents suspected ADHD. Additionally, parents or caregivers were required to have functional English skills to comprehend verbal and written instructions.

Parents of 56 children completed the intake process. Ages of the children ranged from 5.2 to 10.8 years. Five children did not meet eligibility scores. One child dropped out during the study. A total of 45 out of 50 parents in the study returned completed sleep logs. Five participants' parents did not complete the sleep logs, two from the experimental group and three from the control group. All participants in the experimental group documented providing moderate pressure touch massage for a minimum of five days per week during the three weeks of the massage protocol.

Instruments

Short sensory profile

The SSP was used for children aged 5–11. The SSP consists of 38 questions about sensation and behaviour and has seven subscale categories of tactile sensitivity, sensitivity to movement, taste/smell sensitivity, visual/auditory sensitivity, auditory filtering, sensory seeking and low energy. Total raw scores range from 38 to 190, with higher scores corresponding to typical performance. The range for typical performance is between 155 and 190 points. A score of probable difference in performance ranged between 142 and 154 points. The interval of 38–141 corresponds to a definite difference in performance (McIntosh *et al.*, 1999). Consistent with previous studies, eligibility for the study was established by the following criteria: a z-score of ≤ -3 standard deviations (SDs) below the mean for the total score; a z score of ≤ -2.5 SD on two or more subtests; or a z score of ≤ -4 on one subtest (Miller *et al.*, 2007a; Miller *et al.*, 2007b).

Child sleep habits questionnaire

The CSHQ for ages 4–11 is a 33-item questionnaire with eight subscale categories of bedtime resistance, sleep onset delay, sleep duration, sleep anxiety, night awakenings, parasomnias, sleep disordered breathing and daytime sleepiness. A cut-off score of 41 is used to determine significance in a disturbance in sleep quality (Owens *et al.*, 2000). Psychometric data for the CSHQ includes internal consistency of the subscales which ranged from 9 to 56 for parasomnias to 0.93 for bedtime resistance. Test-retest reliability ranged from 0.62 to 0.79 (Owens *et al.*, 2000).

Goal attainment scaling

Goal attainment scaling (GAS) is an individualized measure of parent perceived priorities and is considered to be a reliable and meaningful measure for studies of SPD (Harpster *et al.*, 2017; Mailloux *et al.*, 2007). GAS typically includes three to five personalized goals with a five-point Likert scale with possible scores of −2, −1, 0, +1 and +2. Goals are individualized to meet the concerns of each subject. The score is standardized by writing goals with stages that are spaced the same increment of distance between the stages. In the five increments of scoring used in GAS, the −2 score is the child's current performance, and the 0 score is the anticipated outcome (Kiresuk *et al.*, 1994). A t-score is obtained through use of a combined total score of all the goals and by the number of goals used. In this study, GAS was used for one sensory and one sleep outcome goal.

Sleep log

Sleep logs describe a trajectory of change over time in sleep parameters. This is achieved through manual recording of aspects of sleep, including sleep onset, sleep latency, night awakenings and gaps in total sleep time. The data yields specific information on overall sleep performance of the child as reported by the parents, providing an understanding of how the intervention is affecting sleep. The log is dependent on parent report, which can pose issues if not consistently or accurately completed.

Procedure

Using convenience sampling, parents were recruited through flyers posted at local developmental centers. At the initial meeting, after learning about the study and giving informed consent to participate, eligible parents filled out intake questionnaires. Children who were over age six also signed an assent form if they were agreeable to their participation in the study. Parents were randomly assigned to the control or experimental group and were trained in recording in the sleep log. The experimental group participants also received training in a manualized 15–20-min massage protocol application, based on previous manualized massage studies (Field *et al.*, 2010; Field and Hernandez- Rief, 2001). The massage protocol included joint compressions of both upper and lower extremity joints and moderate pressure touch massage of the upper and lower extremities and upper back. Researcher approval of parental efficacy in the technique was obtained before beginning application of the technique in the study. The control group did not receive nightly massage and instead was read a bedtime story each night for 15–20 min to control for the interaction effect of the child–parent. A home check was performed midway through the study protocol to ensure consistent proficient application of the pressure touch massage protocol for the intervention group.

Sleep log data was recorded for all participants throughout the five-week period of the study.In Week 1, a baseline recording was documented for all participants, including the sleep log data. For the experimental group, the massage protocol was also administered for Weeks 2–4. Week 5 was again a baseline recording for all participants. An exit meeting was then held where parents filled out the posttest questionnaires and received instruction for further sensory needs that arose during this study. All clients were followed up until intervention was no longer effective or no longer necessary.

Data analysis
The following research questions were analyzed:

RQ1. What is the effect of sensory input of moderate pressure touch on the quality of sensory measures in children with SPD who have sensory and sleep disturbances as compared to children who do not receive this input?

RQ2. What is the effect of sensory input of moderate pressure touch on the quality of sleep in children with SPD who have sensory and sleep disturbances as compared to children who do not receive this input?

Results were analyzed using data from the SSP sensory questionnaire and the CSHQ sleep behaviour questionnaire using mixed design analysis of variance (ANOVA) to test the difference between the two treatment groups, control and moderate pressure input intervention groups, to determine if an interaction effect existed between the two groups for total sensory scores and total sleep scores, as well as subgroup scores in those measures. The variable within-participant measures were sleep outcomes at the initial pretest time, labeled Time 1 (henceforth T1) and the final posttest time, labeled Time 5 (henceforth T5). ANOVA was used because there were multiple group comparisons owing to subsection comparisons of each instrument. Observed significance values at <0.05 were considered statistically significant. Results were analyzed for GAS scoring using t-test analysis of the data. A sleep log was used to record nightly sleep patterns. Hierarchical linear modeling (HLM) was used to describe change over time in the sleep log data, in an A-B-B-B-A type manner, with Weeks 1 and 5 being observation and recording of sleep patterns without pressure touch intervention in both the control and intervention groups. Weeks 2–4 reflect the experimental conditions. Trajectories of change were measured for three sleep constructs, time to fall asleep, amount of night awakenings and total sleep time.

Results

Demographics

A total of 50 participants were randomly assigned to two groups, experiment and control, with 25 participants in each group as shown in Table 1. The experimental group had 16 males and 9 females, and the control group had 15 males and 10 females. Distribution of males to females was equivalent using a mode distribution. The average age of the child was 7.4 years for the experimental group and 7.1 years for the control group. The experimental group had two children diagnosed with ADHD and four whose parents suspected ADHD. The control group had one child diagnosed with ADHD and two subjects whose parents suspected ADHD. The average parental age in the experimental group was 35.8 years and 32.7 years in the control group. The average for parental education was 14.4 years in the experimental group and 14.2 in the control group. Both groups had 17 parents who worked and eight parents who stayed at home. No parents were divorced in either group (Table 1).

Table 1 Participant demographics

Demographic variable	Intervention ($n = 25$)	Control ($n = 25$)
Child Gender		
Male	16	15
Female	9	10
ADHD Dx	2	1
Age (years)	7.4	7.1
Parent age (years)	35.8	32.7
Parental education (years)	14.4	14.2
Parental employment	17	17

Associations between the total sleep and sensory scores and the subtest scores
To examine the pattern of association between the sensory measures (tactile sensitivity, taste/smell sensitivity, movement sensitivity, sensation seeking, auditory filtering, low energy, visual/auditory sensitivity and overall sensory problems) and the sleep measures (bedtime resistance, sleep onset delay, sleep duration, sleep anxiety, night waking, parasomnias, sleep disordered breathing, daytime sleepiness and overall sleep problems), a series of Pearson correlations were computed for all 50 participants. In this study, absolute values of 0.1–0.29 were considered modest correlations, 0.3–0.49 were moderate correlations, 0.7 and over were strong correlations, with <0.1 considered weak correlation (Rumsey, 2011).

The analyses indicated that total sensory problems did not significantly correlate with overall sleep problems ($r = 0.04$). However, modest associations between subgroups were noted. Greater daytime sleepiness was associated with heightened tactile sensitivity and taste/smell sensitivity ($r = 0.28$, $p < 0.05$). Night awakenings were associated with lower movement sensitivity ($r = 0.28$, $p < 0.05$). Parasomnias were modestly related to lower energy ($r = 0.27$, $p < 0.05$), as was sleep onset delay ($r = 0.28$, $p < 0.05$). Finally, greater sleep anxiety was modestly linked with higher visual/auditory sensitivity ($r = 0.28$, $p < 0.05$) (Table 2).

Improvement of sensory scores after intervention
A series of mixed-design ANOVA was conducted, in which the study group (intervention, control) served as the between-subject independent measure, and the time of assessment (T1, T5) served as the within-subject independent measure. The dependent measures were the sensory measures (tactile sensitivity, taste/smell sensitivity, movement sensitivity, sensation seeking, auditory filtering, low energy, visual/auditory sensitivity and overall sensory problems), in which a separate analysis was conducted for each dependent variable.

Analyses revealed effects for time on all of the sensory-related measures. Participants' sensitivity was better at Time 5 than at Time 1. To correct for multiple comparisons, a simple main effects test with Bonferroni adjustment was conducted. The analysis indicated that whereas sensory levels remain unchanged among the control group, they significantly improved over time among the intervention group (scores became lower; $p < 0.001$), for the overall sensory score ($F = 76.91$, $p < 0.001$), tactile sensitivity ($F = 25.36$, $p < 0.001$), taste/smell sensitivity ($F = 17.67$, $p < 0.001$),

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Table 2 Pearson correlation coefficients for assessing the associations between sensory and sleep measures

	Tactile sensitivity	Taste/smell sensitivity	Movement sensitivity	Sensation seeking	Auditory filtering	Low energy	Visual/auditory sensitivity	Overall sensory score
Bedtime resistance	−0.16	0.07	−0.25	−0.25	−0.18	−0.15	−0.08	−0.24
Sleep onset delay	−0.02	0.17*	−0.2	−0.1	0.06	−0.28	0.04	−0.07
Sleep duration	−0.23	0.05	−0.05	0.04	−0.13	−0.18	−0.01	−0.14
Sleep anxiety	0.04	0.19*	0.01	−0.01	0.02	−0.03	0.28*	0.11*
Night waking	−0.13	−0.06	−0.28	−0.11	−0.17	0.17*	−0.25	−0.18
Parasomnias	0.15*	−0.09	0.13*	0.15*	−0.05	0.27*	0.07	0.17*
Sleep disordered breathing	0.02	−0.11	0.01	0.05	0.15*	0.11*	0.16*	0.09
Daytime sleepiness	0.28*	0.28*	0.05	−0.16	0.06	0.09	0.25*	0.22*
Overall sleep problems	0.05	0.17*	−0.09	−0.13	−0.07	0.05	0.15*	0.04

Notes: *$p < 0.05$, $r > 0.1$ modest, $r > 0$ moderate, $r > 0.5$ robust correlation

auditory filtering ($F = 35.35$, $p < 0.001$) and visual/auditory sensitivity ($F = 19.50$, $p < 0.001$). Moderately strong results were obtained in movement sensitivity ($F = 10.70$, $p < 0.01$), sensation seeking ($F = 11.47$, $p < 0.01$) and low energy ($F = 12.91$, $p < 0.01$) (Figure 1).

Improvement of sleep scores after intervention

A series of mixed-design ANOVA was conducted in which the study group (intervention, control) served as the between-subject independent measure, time of assessment (T1, T5) served as the within-subject independent measure and sleep measures (bedtime resistance, sleep onset delay, sleep duration, sleep anxiety, night waking, parasomnias, sleep disordered breathing, daytime sleepiness and overall sleep problems) as the dependent measures (separate analysis for each dependent variable).

Analyses revealed main effects for time on all of the sleep-related measures except for sleep disordered breathing: participants' sleep-related behaviours were better at Time 5 than at Time 1. The analyses also revealed main effects for study group on measures of bedtime resistance and sleep onset delay, sleep anxiety and parasomnias and daytime sleepiness: participants in the intervention group had significantly better (i.e. lower scores) bedtime resistance, sleep onset delay, sleep anxiety, parasomnias and daytime sleepiness than controls. However, the effects of either study group and/or time on overall sleep problems, sleep onset delay, sleep duration, sleep anxiety, parasomnias and daytime sleepiness were moderated by the expected interactions between study group and time (Figure 2). A simple main effects test with Bonferroni adjustment indicated that whereas sleep-related scores remain unchanged among the control group, they significantly

Figure 1 Changes in sensory measures over time

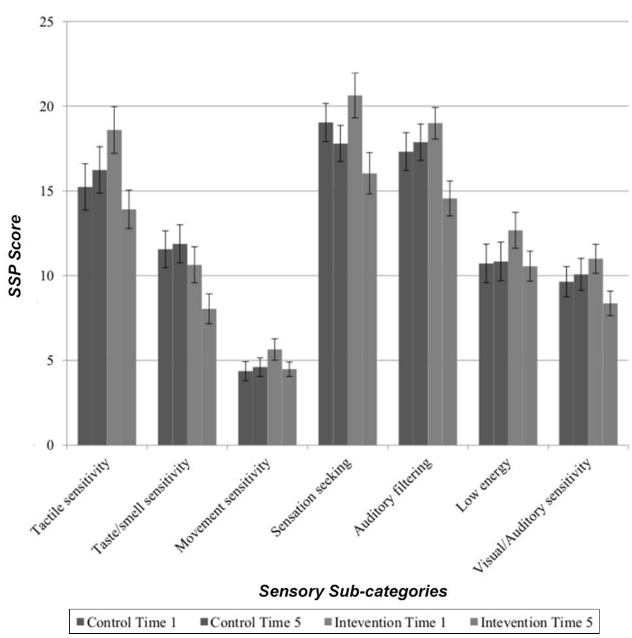
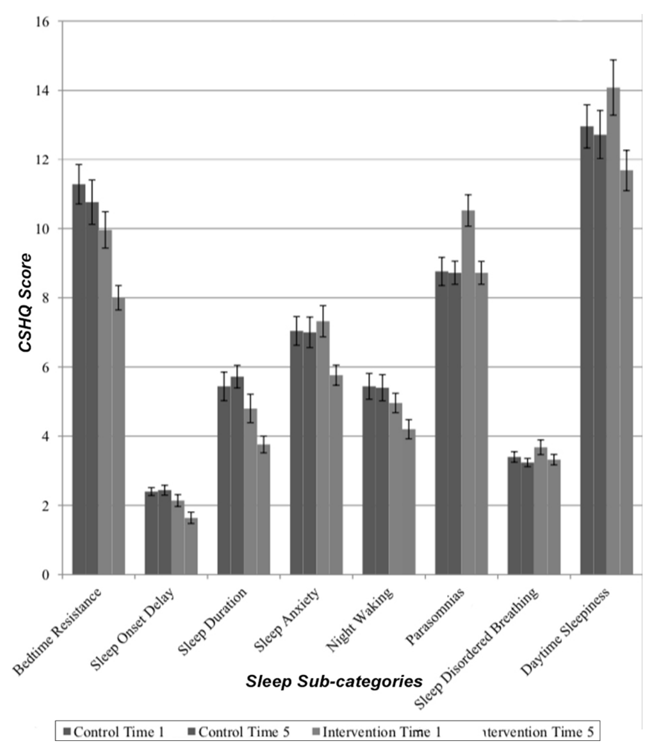


Figure 2 Changes in sleep measures over time



improved over time among the intervention group (scores became lower). Overall sleep scores were of strong significance ($F = 24.71$, $p < 0.001$), and parasomnias were of moderately strong significance ($F = 13.98$, $p < 0.01$). Sleep onset delay ($F = 8.88$, $p < 0.05$), sleep duration ($F = 6.70$, $p < 0.05$), sleep anxiety ($F = 8.30$, $p < 0.05$) and daytime sleepiness ($F = 8.57$, $p < 0.05$) achieved significance as well.

Improvement in goal attainment scaling scores

To examine whether participants of the intervention group had greater increases in individualized goals than controls, an independent samples *t*-test was conducted in which the study group (intervention, control) served as the independent measures and the individualized goals score as the dependent measure. The analysis indicated that the improvement in individualized goals score was greater for participants of the intervention group ($M = 69.71$, SD = 11.23) than controls ($M = 26.82$, SD = 6.02, $t(48) = 16.83$, $p < 0.0001$, Cohen's $d = 4.96$).

Changes in the sleep logs

Analyses were performed to determine whether participants of the intervention group differed from controls in the trajectory of change over time in the following sleep diary measures: sleep latency/time to fall asleep, waking frequency and sleep duration. On the lower level of the HLM analysis (repeated measures level), the sleep-related measures were predicted by the variable of time from Time 1 to Time 5 of the assessment. On the upper level of the analysis (person level), the measure of study group and the interaction between study group and time was added. A significant interaction would indicate that the trajectory of change over time differed between the intervention and control groups.

HLM coefficients are seen in Figure 3. The graphic longitudinal trajectories in Figure 3(a)–3(c) indicate that the intervention and study groups differed significantly in the trajectory of change in time taken to fall asleep (Figure 3a), and in nightly awakenings (Figure 3b), with the intervention group needing less time to fall asleep and waking less often in the night. The groups did not differ significantly in sleep duration/total sleep time (Figure 3c). Additionally, when the massage protocol intervention was ended on Week 4 for the intervention group, an increase in time needed to fall asleep and in waking frequency was noted in Week 5, yet no effect was noted on sleep duration time was noted in Week 5 in the HLM coefficients.

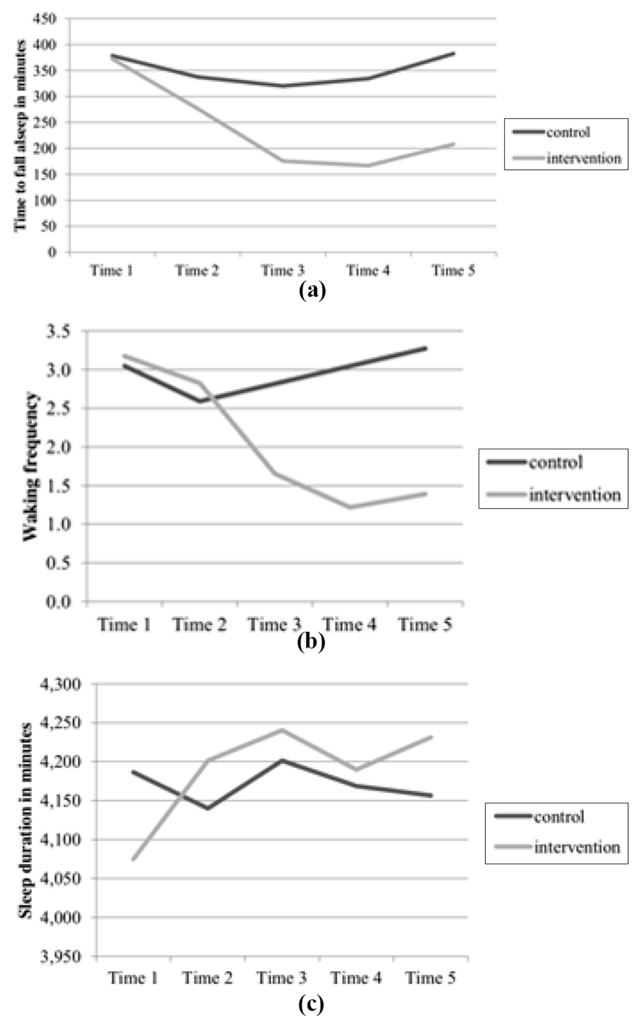
Discussion

This study suggests that use of sensory inputs can influence behavioural sleep parameters in children with sensory difficulties. These results reinforce that relationships between sensory dysfunction and sleep difficulties are found in the literature. One of the most significant factors noted was hypersensitivity (Ben-Sasson *et al.*, 2009; Shani-Adir *et al.*, 2009; Shochat *et al.*, 2009; Vasak *et al.*, 2015). These findings are consistent with this study, which found greater daytime sleepiness was associated with sensitivities in the tactile and taste/smell systems and that sleep anxiety was linked with higher visual/auditory sensitivity.

Application of moderate pressure touch significantly improved all sensory measures assessed: tactile sensitivity, taste/smell sensitivity, movement sensitivity, sensation seeking, auditory filtering, low energy and visual/auditory sensitivity. Use of sensory input to improve sensory dysfunction has been noted in the pediatric sensory literature for many populations such as ADHD, ASD, Fragile X and more (Nielsen *et al.*, 2017; Schaaf, 2011; Weitlauf *et al.*, 2017). Specific use of massage, a type of moderate level tactile pressure, has been noted to improve sensory function in infants and toddlers (Field, 2014; Hendel, 2017). The literature is consistent with the findings of this study regarding the efficacy of moderate pressure touch and/or massage touch.

This is the first OT intervention study to use moderate pressure input to improve sleep measures. Use of moderate pressure touch was noted to improve behavioural sleep measures including the overall sleep score and subtests of sleep onset, sleep duration, sleep anxiety, parasomnias and daytime sleepiness. Few intervention studies exist in the literature with application of sensory measures to improve sleep in children with SPD. These findings then contribute to the knowledge about efficacious OT interventions for

Figure 3 Hierarchical linear modeling of sleep log data



sleep disturbances in children with sensory processing difficulties.

GAS outcomes were significant for sensory and sleep measures. Goals were unique and relevant to the families. Use of GAS to set goals enables families to participate in OT interventions in ways that are meaningful to them. Use of GAS to measure participation and satisfaction with therapy outcomes is consistent with the literature (Harpster *et al.*, 2019; Herdman *et al.*, 2019).

Sleep logs or sleep diaries are a way for families to track if the intervention is effective. In this study, after a week of no change in baseline conditions, improvement was noted by a reduction in sleep latency or the time needed to fall asleep and a reduction in the number of wakenings during the night. No differences between the control group and experimental groups were found in sleep duration. It may be possible that total sleep time is less affected by external inputs such as pressure touch. Upon removal of the OT intervention in Week 5, the time to fall asleep and number of night awakenings again began to rise.

Implications for practice/families

Findings from this study support the view of an approach in intervention for children with SPD that considers the child's responsivity to sensory input. This study found that the sensory input of moderate pressure touch effectively lowered arousal levels in both sensory and sleep measures. When the sensory intervention was discontinued, immediate worsening of sleep patterns was noted. This knowledge may be used when planning effective treatment choices in SPD, particularly for goals of improved sleep behaviour.

This study offered an alternative to traditional therapist treatment of SPD by training parents to deliver a home intervention. Parent massage is both cost-effective to the health system and supports principles of the World Health Organization's International Classification of Functioning, Disability and Health that supports function and participation within the context of family life (World Health Organization, 2001). Use of parent massage offers families a way to obtain significant improvement without extensive visits to a therapy clinic, does not interrupt the daily flow of family life and empowers families to participate in improving the well-being of their child. This approach is consistent with the vision of the profession of OT of empowerment and of family-centered practice.

This study strengthened the use of OT intervention for the domain of sleep. This is one of the few studies where a sensory intervention was successful in improving sleep behaviours in children with SPD, specifically moderate pressure touch. Therapists should inquire about sleep habits when treating children with SPD and should include sleep improvement in the goals for these children. Particular attention should be paid to lowering arousal to a level consistent with sleep and noting improvement in bedtime resistance behaviours.

Family cohesiveness may be disrupted when a child with SPD does not fall asleep in a timely manner, rouse in a regulated manner or exhibits daytime sleepiness during daily tasks as the well-being of the family depends on each family member contributing to the functioning of the whole system (Cohn *et al.*, 2000). Empowerment of parents who are able to provide remediation for some sleep difficulties via massage for their child with supervised guidance by an occupational therapist is within the scope of OT practice (AOTA, 2017). Sleep intervention may typically include establishment of nighttime routines or addressing environmental supports to enhance occupational functioning of the child–family unit (Kidney *et al.*, 2020). This study supports the addition of nighttime pressure touch "massage" to the intervention tools for this problem.

Limitations

Threats to internal validity included possible bias in subject selection. Volunteer participants were recruited by a convenience sample and not by random selection. Parent bias in answering questionnaires must be considered as a threat to internal validity, as well as use of parent response instead of direct child response. Examiner bias must be considered as test group conditions were not blinded to the PI. Although parents received training in the massage protocol, and a home visit during the study was conducted to ensure consistent application of pressure, consistent application of moderate pressure touch was unable to be fully confirmed. Threats to external validity include limited ability to generalize to wider populations owing to small sample size and owing to subject selection from a single site.

Implications for future research

This dissertation study contributes to the growing body of knowledge regarding the ability to influence arousal levels in children with SPD and how this knowledge may be used to build OT interventions. The study provides initial evidence that providing moderate pressure touch to children with SPD can improve behavioural sleep difficulties. It is recommended that future researchers in SPD take note of the instruments in the current study which yielded sensitive measures of change. However, to strengthen the initial claims of a link between behavioural sleep problems and children with SPD, assessment tools such as actigraphy or polysomnography to further investigate these conclusions would add support and are within the scope of OT research instruments. The majority of SPD intervention efficacy in the literature has focused on outcomes and not on the manner of delivery. Intervention studies of SPD tend to espouse general sensory techniques or focus on outcomes without specifying the delivery of the input (Miller *et al.*, 2007b; Smith *et al.*, 2005). This study achieved significant results with input given once daily but with a longer amount of time of application of the moderate pressure touch input. Future research could measure the effectiveness of sensory input with different service delivery configurations.

Summary

This study investigated an OT sensory intervention to mitigate disrupted sleep behaviours of children with SPD. Use of sensory input is a compatible intervention tool for pediatric occupational therapists. Reduction of time to fall asleep and reduced night awakenings were noted, as were decreased daytime sleepiness, sleep anxiety and parasomnias. This randomized intervention study adds evidence to the literature that use of moderate pressure touch can be used in clinical practice to improve sleep participation in children with sensory disorders.

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