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EXPLORATORY STUDY

Sensory Processing Assessment and Feedback in the Treatment of Complex Developmental Trauma

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Abstract
This study explored the impact of a sensory processing assessment, recommendations and feedback process on the functioning at school and after-hours environments of children who had been traumatised by abuse. A mixed methods design (Schoonenboom & Johnson, 2017) was utilized incorporating pre (12 months prior) and post (four to eight months after the report) repeated child focused measure, alongside thematic analysis of participants qualitative survey feedback. The methodology included two stages: firstly, an occupational therapy assessment of young people referred by *Own Organisation* clinicians for a sensory processing assessment and secondly, an evaluation was conducted of the impact of occupational therapy on the young person's behaviour and their carers. The study found significant improvement in family life and relationships as well as a reduction in impairment as evidenced by decreases in HoNOSCA scores across problems with family life and relationships, non-accidental self-injury, problems with emotional and related symptoms, poor school attendance and on the social subscale. These findings were supported by clinician participant reports. A sensory processing assessment provided young people, their carers and teachers with information which contributed to environmental adaptations. These environmental adaptations were associated with improved functioning and behaviour of young people impacted by child abuse. It is recommended future research attempt to replicate and extend our understanding of how sensory processing assessments and interventions can increase children's wellbeing.

Keywords Occupational Therapy · Sensory Processing · Child Maltreatment · Neglect · Child Abuse · Complex Trauma

Introduction

This study explored the impact of a sensory processing assessment, recommendations and feedback process on the functioning at school and after-hours environments on children who had been traumatised by abuse. In addition, the knowledge translation of the sensory processing assessment findings into interventions by clinicians was also explored. It was hypothesised that following the intervention of sensory assessment and feedback to carers and participants there would be changes to the environment that better met participants sensory processing preferences, leading to improvements in sensory modulation, occupational functioning and the caring relationship. These improvements were primarily evaluated by the Health of the Nation Outcome Scales for Children and Adolescents (HoNOSCA) and supplemented by clinician participant feedback post-assessment and a feedback process.

In this paper complex trauma is defined and then the literature related to sensory modulation, the impact of trauma on the development and experience of sensory modulation as well as the efficacy of sensory interventions is presented. The approach being evaluated is detailed along with the methodology utilized to explore its utility with traumatized young people.

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Literature Review

Complex Trauma

Complex traumatic exposure refers to multiple, repeated or prolonged traumatic events, including abuse, neglect, family violence or abandonment negatively impacting children at developmentally vulnerable periods that occur within the caregiving system (Ford & Courtois, 2020).

The Importance of Sensory Integration in Development

Sensory integration, (Ayres, 1972) is a neurodevelopmental process beginning before birth. In this process, information is received through the sensory pathways before being, organized, integrated and modulated to facilitate adaptive behaviours. Positive multisensory experiences are an essential ingredient of the infant's attachment with his primary caregivers (Kennedy & Lane, 2014; Purvis et al., 2013). Under such optimal relational circumstances, children and young people are likely to become proficient at taking in sensory information in order to react adaptively to their environments (Lickliter, 2011).

Processing of sensory signals becomes increasingly integrated over time under optimal developmental conditions (Lickliter, 2011). Integration of sensory signals commences in utero where the developing infant experiences a variety of tactile, vestibular, chemical and auditory sensory stimuli (Lickliter, 2011). Positive multisensory experiences are an essential ingredient of the infant's attachment with his primary caregivers (Kennedy & Lane, 2014; Purvis et al., 2013) resulting in both structural and functional nervous system development (O'Brien & Lynch, 2011). Tactile integration incorporating vestibular and proprioceptive stimulation is foundational to the formation of a bond between mother and infant, being a key feature in attending to the infant's daily routines. Touch is one of the primary sensory pathways parents utilize to express love and care to their infant. The touch system is part of the somatosensory system comprising neural input through both the dorsal column medial leminscal neural tract (DCML) and the pathways of the anterolateral neural system (AL). The DCML is associated with the functions of touch perception or discrimination while the AL system is composed of separate pathways which primarily mediate pain, crude touch and temperature. The playful, safe touch of objects in the environment in parallel with their caregiver's behavior during infancy creates the cornerstone of emergent fine motor skill, and bilateral upper limb coordination in infants. However, the absence of these important developmental opportunities can lead to an underdevelopment of the discriminatory touch system (DCML pathway) which in turn can have a significant negative effect on the development of fine motor skills and cognition.

Children with adequate sensory processing are able to make use of positive caregiving to co-regulate in stressful situations and with increasing age and development are able to utilize internal and external resources to self-regulate. This enables them to form positive relationships, learn and explore their environment in a developmentally appropriate manner.

Sensory Modulation

This is defined as "the capacity to regulate and organize the degree, intensity and nature of responses to sensory input in a graded and adaptive manner. This allows the individual to achieve and maintain an optimal range of performance and to adapt to challenges in daily life" (Miller et al., 2001, p.57).

Sensory modulation develops in the first few years of life, when infants learn to attend to the environment while also regulating arousal and responding to stimulation (Parham & Mailloux, 2010). It is facilitated through positive attuned parenting in everyday caregiving and playful activities (Eisenberg et al., 2005; Ferber et al., 2008) and is observed in the parent who responds to a distressed infant by such behaviors as rocking, patting and making soothing noises such as singing a lullaby.

Sensory Modulation Disorders

Sensory modulation disorders have been noted to occur in 5–16% of typically developing children (Yochman & Pat-Horenczyk, 2020). Conducted a study of 53 children aged 7 months to 7 years 10 months who had experienced substantiated child abuse and/or neglect. The majority of the children in the study were in foster care (74%) and 23% children identified as Aboriginal or Torres Strait Islander. The children were assessed using the carer rated Sensory Profile -2 (Dunn, 2014), between Feb 2016 – March 2017. Female toddlers (0–3 years) responded more to visual experiences compared with males of the same age ($p=0.027$). Male children ($n=21$; $p=0.022$) and Aboriginal male and female children ($n=6$; $p=0.013$), aged 4–7 years, required greater sensory input before responding. Carers reported older children between the ages of 7–7.11 years ($p=0.006$) draped themselves over furniture, moving stiffly or propping on furniture to support themselves, demonstrating a need for greater sensory motor input through the use of their body.

In another study, children aged 7 to 11 years diagnosed with Post-Traumatic Stress Disorder (PTSD) in Israel were found to have significant sensory modulation difficulties compared to children from the same sample who had not developed PTSD ($n=134$). Children with post-traumatic stress (PTS) symptoms in this study were found to have difficulties responding to various types of stimulation in daily-life activities beyond what might be considered trauma-related stimuli (Yochman & Pat-Horenczyk, 2020). A four year follow up of the Yochman and Pat-Horenczyk (2020) study cohort found evidence of relational PTSD in that PTS in mothers at time one predicted PTSD in mothers at time two and this in turn was linked with their childrens' sensory and behavioural dysregulation and reduced executive functioning (Yochman & Pat-Horenczyk, 2020).

A study of the sensory processing capacities of 8–12-year-old children (n = 297) living in the United States of America (USA), compared three groups of children (Willbarger et al., 2010). The first group consisted of children who had experienced greater than 12 months of institutionalized care prior to international adoption (n = 123). The second group was children internationally adopted before 8 months of age who were predominantly from foster care environments (n = 85) and the third group consisted of non-adopted children raised by their birth parents in the USA (n = 89). The study found the children who had experienced predominantly institutionalized care prior to adoption were experiencing higher levels of reactivity to sensation and reduced response regulation compared with the foster care adoptees and birth parent raised group of children who did not differ on any of the sensory processing measures.

It was noted by Bailliard and Whigham (2017) that there has been extremely limited research focused on assessing the impact on everyday life situations of sensory processing difficulties.

Impact of Trauma

The impact of trauma on children's functioning has been well established over the last 30 years (Cook et al., 2005). There is evidence that trauma and neglect can result in neurobiological changes (Perry, 2008; Van der Kolk, 2003) difficulties building and maintaining attachment relationships (Schore, 2003; Soma et al., 2021), decreased self-regulatory ability (Villalta et al., 2018), behavioural difficulties (Cook et al., 2008) impaired cognitive functioning (Beers & De Bellis, 2002) and diminished capacity to 'integrate sensory, emotional and cognitive information into a cohesive whole '(Van der Kolk, 2005, p. 402). Being in a fight or flight state for long periods of time affects the child's ability to integrate sensory information to facilitate adaptive responses to the environment and perceived stressors (Van Der Kolk, 2003).

Assessment of children who have experienced trauma needs to be multi-facted cognizant of the potential developmental, sensory processing, behavioural, social and emotional impacts on the developing child and their brain (Perry, 2020). Multidisciplinary assessment is often required due to the complex developmental sequelae, ensuring interventions to be focused, individualized and prioritized (Ryan et al., 2017).

Continuing Impact of Trauma on Protective Touch System

Young people who have been exposed to abuse and neglect in infancy have often missed out on core positive touch-based interactions with their caregivers such as firm touch, light affectionate touch, holding, functional and passive touch. Without this experience of positive touch, the AL system which is a threat-driven, protective system with faster reacting neural pathways remains the default pathway. This means the child's autonomic nervous system is activated to perceive the touch as threatening and respond accordingly. The child remains primed to perceive other-directed touch as threatening rather than activating the DCML system where a child associates touch with nurture, comfort, play and skill acquisition (Bundy et al., 2002).

The absence of these important developmental opportunities can lead to an underdevelopment of the discriminatory touch system (DCML pathway) which in turn can have a significant negative effect on the development of fine motor skills and cognition.

The impact of complex childhood trauma can extend into adulthood with increased incidence of depression, drug and alcohol abuse, sexual risk behaviour, domestic violence and health difficulties (including heart disease, cancer, lung and liver disease) in adults (Gilbert et al., 2015; Matto et al,, 2021). Lower registration of sensory input as well as sensory sensitivity and avoidance were correlated with childhood traumatic experiences in a group of adults with unipolar and bipolar disorders. (Serafini et al., 2016).

Sensory-Motor Interventions to address Impacts of Complex Trauma

Modulation of physiological arousal through sensory-motor interventions can assist people to more effectively participate in their daily routines, relationships and occupational activities through the development of a sense of agency and mastery over their bodily responses. (Novak et al., 2012; Warner, Spinazzola et al., 2014).

A scoping review of sensory-based interventions with children and young people who had experienced developmental trauma (Fraser et al., 2017) concluded that although empirical evidence was limited, sensory-based interventions yielded promising results and need to be incorporated into an "overall treatment program with a multidisciplinary focus" (p.213).

Australian adolescents using sensory tools in sensory rooms in an acute psychiatric unit reported significantly reduced distress and were observed to have significantly less disruptive behaviours after their use (Novak et al., 2012). Warner, Cook et al. (2014), Warner, Spinazzola et al., 2014) in developing the Sensory Motor Arousal Regulation Treatment (SMART) acknowledged the importance of expanding children's zone of optimal arousal. This occurred through the development of new regulatory experiences, teaching caregivers to co-regulate with children and processing traumatic memories through sensorimotor play and dialogue. SMART intervention resulted in a significant decrease in internalising symptoms, somatic complaints, anxiety and depression with a polyvictimized sample at two adolescent

residential treatment sites (Warner, Cook et al., 2014, Warner, Spinazzola et al., 2014).

A case-based study by Finn et al. (2018) examined the clinical outcomes of six months of SMART therapy with a dysregulated seven years- old boy who was adopted when he was three years of age after being removed from his parent's care. The positive clinical outcomes were cited as an example of how traumatised children can more readily regulate their bodies, become more behaviourally organized, and relationally competent when engaging in embodied sensorimotor play- based therapy with an attuned therapist.

The utility of the 'Safe-Place Intervention 'was examined in a single-case study by May-Benson and Teasedale (2020). This multi-disciplinary intervention program for children with complex trauma and sensory processing disorder was based on the theoretical model developed by Jane Koomar and Dan Hughes (May-Benson & Teasdale, 2020). It utilizes a "sensory-based, mind–body and attachment-focused framework to healing trauma and restoring resilience in children and families." (p.216). Preliminary effectiveness suggested improvements in areas of motor performance, sensory processing and behavioural regulation. Intervention consisted of twice weekly dyadic treatment sessions for parent and child over 12 weeks, a weekly parent consultation session and a weekly professionals' case conference.

A USA study Purvis et al., (2013) evaluated the benefits of embedding sensory-motor strategies designed by Occupational Therapists into two 3-week therapeutic day camp programs for children who had been adopted either domestically or internationally and who had experienced developmental trauma (n = 18). The children were aged 3–14 years with one group consisting of children aged 3–9 years and the second group consisting of children aged 10–14 years of age. Pre-test measures indicated children with sensory deficits, were described by their adoptive parents as displaying less positive attachment behaviours. The children who were identified prior to the camp as having significant deficits in two or more of occupational therapy domains (eye-hand coordination, proprioception, muscle tone, coordination, visual, tactile, vestibular or auditory or olfactory processing) were significantly more likely to display pro-social and expressive language gains following the camp ($p < 0.05$). Parents reported the younger male children (who all had a history of institutionalized care) displayed greater positive attachment behaviours and increased expressive language following the camp.

A mixed method study by Dowdy et al. (2020) examined the rates of violence exhibited by males aged 15–20 years residing in a USA Mid-Western maximum-security juvenile correction facility. The study compared a group referred for occupational therapy (n = 76) with a non-referred group (n = 76). The study group were identified as demonstrating higher rates of acts of violence (AoV) and needing to build positive self-regulation strategies. There was a significant correlation, in the group referred for occupational therapy, between reported adverse childhood events and low registration and sensory avoiding as measured on the Adolescent/Adult Sensory Profile (Brown & Dunn, 2002). The group who received occupational therapy displayed significantly lower rates of violence following the intervention ($p = < 0.001$) with the rate indistinguishable from the non-referred group. There was no significant change in the average acts of violence rates and length of time between acts of violence for the non-referred group ($p = 0.859$).

Tactile stimulation, especially massage, shows the best clinical evidence of three sensory based interventions for reduction of behavioral problems in children including improving inattention and participation in the classroom and increasing the ability to socialize, compared to proprioceptive and vestibular stimulations (Wan Yunus et al., 2015). However, Ayres (2005) recommends caution in generalizing such findings to practice, emphasizing dysfunction in sensory processing is multilayered without reliance on a single sensory system. Applying singular tactile, proprioceptive or vestibular stimulations alone may not fulfill all the complicated sensory needs of the children. (Wan Yunus et al., 2015).

The research evidence discussed above indicates that children impacted by complex trauma may be experiencing sensory processing challenges and benefit from interventions that address these challenges.

Research on the effectiveness of sensory interventions for child maltreatment populations is limited. While research has been completed internationally (Cook et al., 2005; Fraser et al., 2017; May-Benson & Teasedale, 2020; Purvis et al., 2013; Wilbarger et al., 2010; Yochman & Pat-Horenczyk, 2020), none have focused on an Australian population of children in out of home care. This study addresses this gap in knowledge, focusing on the utilisation of a sensory processing assessment with recommended interventions to improve sensory processing capacities, in children who have experienced maltreatment.

Study Context

Berry Sreet Take Two incorporates a state-wide program funded by the Department of Families, Fairness and Housing (DFFH) to provide an intensive therapeutic service to Child Protection clients who have experienced maltreatment in Victoria, Australia (Frederico, et al., 2019). These clients are at risk of developing or already demonstrate emotional and/or behavioural disturbance. Standardised assessments, including the HoNOSCA are utilised at multiple time points to evaluate the efficacy of interventions.

This study received philanthropic funding to examine the effectiveness of sensory processing assessments with young

people who had experienced complex trauma. An Occupational Therapist (second author) was recruited to assist clinicians and care teams in understanding how a child's patterns of hyper/hyposensitivity may be impacting on their presentation; the relationship between sensory processing patterns and a child's trauma/neglect experience. This information combined with knowledge about the child's adaptive sensory preferences, interests and strengths were utilised in intervention planning to assist the child to participate fully in their daily occupations and develop more effective self-soothing strategies within the context of a nurturing caregiving relationship.

Method

Purpose

The specific aims of the study were to conduct an outcome evaluation incorporating a pre- post design (Polgar & Thomas, 2011) to understand the impact of the sensory assessment and recommended interventions on the child's functioning and also to undertake a process evaluation (Oakley, et al., 2006) exploring *Own Organisation* participants experiences of sensory assessments and feedback. It was hypothesized a sensory processing assessment would lead to identification and implementation of effective sensory processing interventions with positive child outcomes.

Research Design

A mixed methods design (Schoonenboom & Johnson, 2017) was utilized incorporating pre (12 months prior) and post (four to eight months after the report) repeated child focused measure, alongside thematic analysis (Terry et al., 2017) of *Own Organisation* participants qualitative survey feedback. The methodology included two stages.

The first stage was the occupational therapy assessment of young people referred by *Own Organisation* for a sensory processing assessment.

In the first stage, occupational therapy assessment was inclusive of standardized and non-standardized questionnaires. In addition, interviews were held with carers, young people (where appropriate), clinicians and educators to gather information for the assessment. Following assessment, there was a feedback session with the carer, *Own Organisation* clinician and other care team members with the provision of a written report.

In the second stage an evaluation was conducted of the impact of knowledge from the occupational therapy assessment on the young person's behaviour and their carers behaviours towards the child.

The impact of this intervention on individual children was evaluated by the clinician rated HoNOSCA and clinician survey regarding their perception of the occupational therapy assessment process and outcomes.

The focus of the evaluation was to explore the difference made to the behaviour of individual children and thus there was no control group used in this evaluation. The data from the sensory processing assessments were triangulated with the HONOSCA to identify change in the child's functioning.

Occupational Therapy Approach

The Occupational Therapist's approach was collaborative and invitational, overtly seeking input from the carer as the subject/content expert on the topic of the child in their care. The assumption of expertise was seen to be held by the care team as the community holding the child in mind with their best interests as the basis for decision making. The Occupational Therapist utilised the Berry Street Take Two framework (Frederico, et al., 2019) and brought a sensory and occupational lens to understanding the child's behaviour and functional capacity. In addition, the occupational therapist approached the assessment process from the position of one who is deeply listening (Rome, 2010) to the caregiver's experiences and to the emotions underpinning a carer's responses to the child's behaviours.

The Occupational Therapist explored the meaning of the child's presentation to the carer and utilized information about the child's sensory processing patterns to develop and test hypothesis for the carer to gain greater understanding of the child's drivers for their presentation. The Occupational Therapist's approach was informed by an understanding of child development (Case-Smith & Clifford O'Brien, 2010), attachment (Heard et al., 2011), therapeutic use of self (Nicholls et al., 2013). Sensory Integration (Bundy et al., 2002), trauma (Van Der Kolk, 2014), Psychodynamic (Bohleber, 2013) and ecological theory (Hinojosa et al., 2017).

The suite of Sensory Profile Assessments devised by Dunn (2014) were utilised to determine the client's sensory processing patterns and preferences. The assessment tools were scored, and a report completed by the Occupational Therapist was provided to carers, clinicians and children. The report included assessment results as well as translation of the findings into intervention strategies for implementation by non-Occupational Therapists engaging with the young person. Telephone based interviews were conducted by the Occupational Therapist with caregivers and teachers to complete the questionnaires.

Assessment feedback was provided to caregivers and children over the phone or by video conferencing at a caregiver and professionals meeting also attended by *Organisation* clinicians and other professionals involved in the child's life. This feedback session provided a further opportunity

for the Occupational Therapist to explain the purpose of the Sensory Processing Assessment Reports, the findings, therapeutic recommendations and invite feedback from the care team about additional strategies, equipment, and other resources that may benefit the child/young person's adaptive functioning. The approach to feedback was to assist care team members to translate the findings in a meaningful way in relation to their engagement with the child. The outcome of this collaboration is inclusion of shared learnings into the final report and actions. The document then became one that was conjointly contributed to by many for the benefits of the child/young person's wellbeing.

The assessment included ongoing liaison with *organisation* clinicians for their observations and information about their client's care and education environment which were often changeable. They were regarded by the Occupational Therapist as holders of vital knowledge about the clients, carers and care systems, and their opinion was sought regarding indications for inclusion of an individualized, strengths- based narrative of the child's sensory processing patterns, known as a *Sensory Story* (Grace & Silva, 2017).

Measures

The Sensory Profile suite of tools consist of a number of tools that were age contingent. The Sensory Profile 2 (Dunn, 2014) was utilised to determine client sensory preferences and completed by caregivers for all participants.

The Sensory Profile 2 Child Record Form (Dunn, 2014) is an 86-item parent/caregiver report questionnaire for children aged three years to 14 years and 11 months. The parent or carer rates statements relating to sensory processing on a 6-point Likert scale. In a study involving 55 participants, Ohl et al., (2010) found the Sensory Profile Child Record. Form to have acceptable test–retest reliability across quadrant scores (ICC = 0.80-0.90), factor scores (ICC = 0.69-0.88) and section scores (ICC = 0.50-0.87). Internal consistency varied from moderate to high (quadrants: as = 0.89-0.95; factor scores: as = 0.82-0.93; section scores: as = 0.67- 0.93). Brown et al. (2008) compared the Sensory Profiles of 26 children with Autism Spectrum Disorder with 26 typically developing children, finding positive evidence of discriminant validity of the Sensory profile scores between the two groups of children. The Sensory Profile Adolescent Record Form (Brown & Dunn, 2002) is a 60 item self-report questionnaire for children over 15-years-old. The Sensory Profile 2 School Companion Record Form (Dunn, 2014) is a 44-item teacher report questionnaire for children aged three years to 14 years and 11 months. The School Companion Record Form also provides outcomes on the need for external supports, awareness and attention, tolerance and availability for learning.

Additional non-standardised questionnaires, the Sensory Tendencies and Preferences Questionnaire (Champagne, 2011), the Sensory Modulation Screening Tool (Champagne, 2011) and a modified Massachusetts Department of Mental Health safety tool (Massachusetts, 2006) were utilised to understand more about the sensory based activities the participants found helpful and the ones they disliked or avoided. Picture-based safety questionnaires were completed by young children with their carers or independently by older children and adolescents. These sought to gain the child/young person's perception of the somato-sensory ways they calm and sooth themselves and their awareness of triggers and warning signs they experience in their body and mind.

The Sensory Profile Adolescent Record Form (Brown & Dunn, 2002) was administered to ten young people aged between 15 and 18 years old. The use of the Adolescent Self-Record Form depended upon the young person's capacity to complete the assessment, their availability to complete the assessment, their attitude towards assessment and their caregiver's decision making on the basis of learning/behavioural challenges. Finally, the Sensory Profile 2 School Companion Record Form was completed by 49 school teachers when the child or young person was regularly attending school and if their difficulties were generalised to the school environment.

The HoNOSCA (Gowers et al., 1999) is a 15-scale clinician rated tool designed to assess child and adolescent mental health. Scales are rated on a 5-point Likert scale, with a score of 0 suggesting no problem and a score of 4 suggesting a severe to very severe problem within the last two weeks. Clinicians are also able to select a score of 9 if there is not enough information present. The HoNOSCA provides scores across all 15 scales, and the addition of the first 13 scales calculate a total score. The HONOSCA has adequate reliability and validity across the individual scales and total scores (Hanssen-Bauer et al., 2010; Pirkis et al., 2005).

The HoNOSCA groups the 13 scales into five sections. Initial reliability analysis of this grouping into sections (Gowers et al., 2000) has not been replicated (Pirkis et al., 2005; Tiffin & Rolling, 2012). For this study, the initially proposed sections were used due to their logical groupings and the lack of alternatives. However, it is acknowledged that these results should be viewed with caution.

Participants

There were 4 groups of participants (children and young people; carers; clinicians and teachers). The children and young people participants were existing clients of *Own Organisation* referred for Occupational Therapy assessments by *Own Organisation* Two clinician participants. Between July 2015 and August 2018, 114 referrals were received for Occupational Therapy. Four of these client participants completed their work

with *Own Organisation* without a Sensory Processing assessment able to be completed; one referral was withdrawn, two referrals were deferred and did not proceed, on client disengaged from service provision and one client was referred to a private practitioner. Sensory Processing assessments were completed for the remaining 105 child and young people participants forming the study sample.

A HoNOSCA was completed within 12 months of the Sensory Processing assessment with 81 children and young people participants in the sample with 31 having a repeat HoNOSCA completed within 4–8 months post Sensory Processing assessment (See Fig. 1).

Surveys were sent to 15 clinician participants regarding young people with 11 returned. Three children and young people participants had completed their work with *Own Organisation* and the clinician participants were no longer having contact and unable to answer survey questions and one clinician was no longer available.

The child and young people participant age range were three to 17 years old with a mean age of 10 years. Of the child and young people participants, 32 (30.5%) were female, 73 (69.5%) male and 35.2% identified as Aboriginal or Torres Strait Islander. Participants were living in foster care (41%), with family (35.2%) or residential care (23.8%). Figure 2 depicts the diagnoses relevant to participants. Subclinical diagnoses were also examined, with Post Traumatic Stress Disorder (PTSD) presenting as the most common subclinical presentation, followed by anxiety, Attention Deficit Hyperactivity Disorder (ADHD) and suspected Autism Spectrum Disorder.

Figure 1 outlines a flow chart of the child and young people participants and the breakdown of data available for each group.

Procedure

Telephone based interviews were conducted by the Occupational Therapist with participant caregivers, clinicians and teachers as part of the completion of the questionnaires and afterwards to ensure the report's recommendations were individualized. The first telephone or video interviews were focused on collecting data to complete the Sensory Profile assessment tool. The Occupational Therapist conducted the second telephone or video interviews to provide feedback and discuss recommendations regarding suggested interventions with participant clinicians, carers, young person (where appropriate) and care team members. At both the assessment and feedback stages, the Occupational Therapist utilised the interviews to provide validation of the participant caregivers' appropriate efforts in attuning themselves to their participant child's patterns of self- regulation.

The approach to feedback was to present the findings in a way which assisted care team members to translate the findings into practice in relation to their engagement with the child. The outcome of this collaboration was inclusion of shared learnings into the final report and actions. The document then became one that was conjointly contributed to by the occupational therapist, *organization* clinician, carers, teachers and, where appropriate, the child, for the benefit of the child/young person's wellbeing. A copy was provided to carers, clinicians and young people. The report included assessment results as well as translation of the findings into intervention strategies for implementation by non-Occupational Therapists engaging with the young person. In addition, psychoeducation with caregivers about the potential impact on sensory processing of complex developmental trauma and the therapeutic possibilities of sensorimotor strategies in assisting a child to develop their self-regulatory capacities in home and school environments was provided. The occupational therapist provided validation to educators when they utilised effective approaches such as the use of their voice, eye contact without required return eye contact, touch and proximity to support the child in the educational setting.

Knowledge Exchange

The occupational therapist/researcher shared their knowledge, accumulated from interaction with a range of educators/carers regarding appropriate approaches with traumatised children experiencing regulatory challenges, with other educators/carers. This approach acknowledged challenges many educators had faced in the classroom in assisting children to become/remain regulated and enabled them to consider alternative approaches. For example, one teacher used her individualized knowledge of a touch- sensitive child to ensure that she checked in with that child as to what he regarded as '*safe touch*' (firm pressure on shoulders), (Purvis et al., 2011) usually after the teacher had established eye contact and gained the child's attention through saying their name. The child identified that this firm safe touch calmed and helped them focus.

The assessment included ongoing liaison with *Own Organisation* clinicians for their observations and information about their client's care and education environment which were often changeable. Clinicians were regarded by the Occupational Therapist as holders of vital knowledge about the clients, carers and care systems, and their opinion was sought regarding indications for inclusion of an individualized, strengths-based narrative of the child's sensory processing patterns, also described as a Sensory Story (Grace & Silva, 2017).

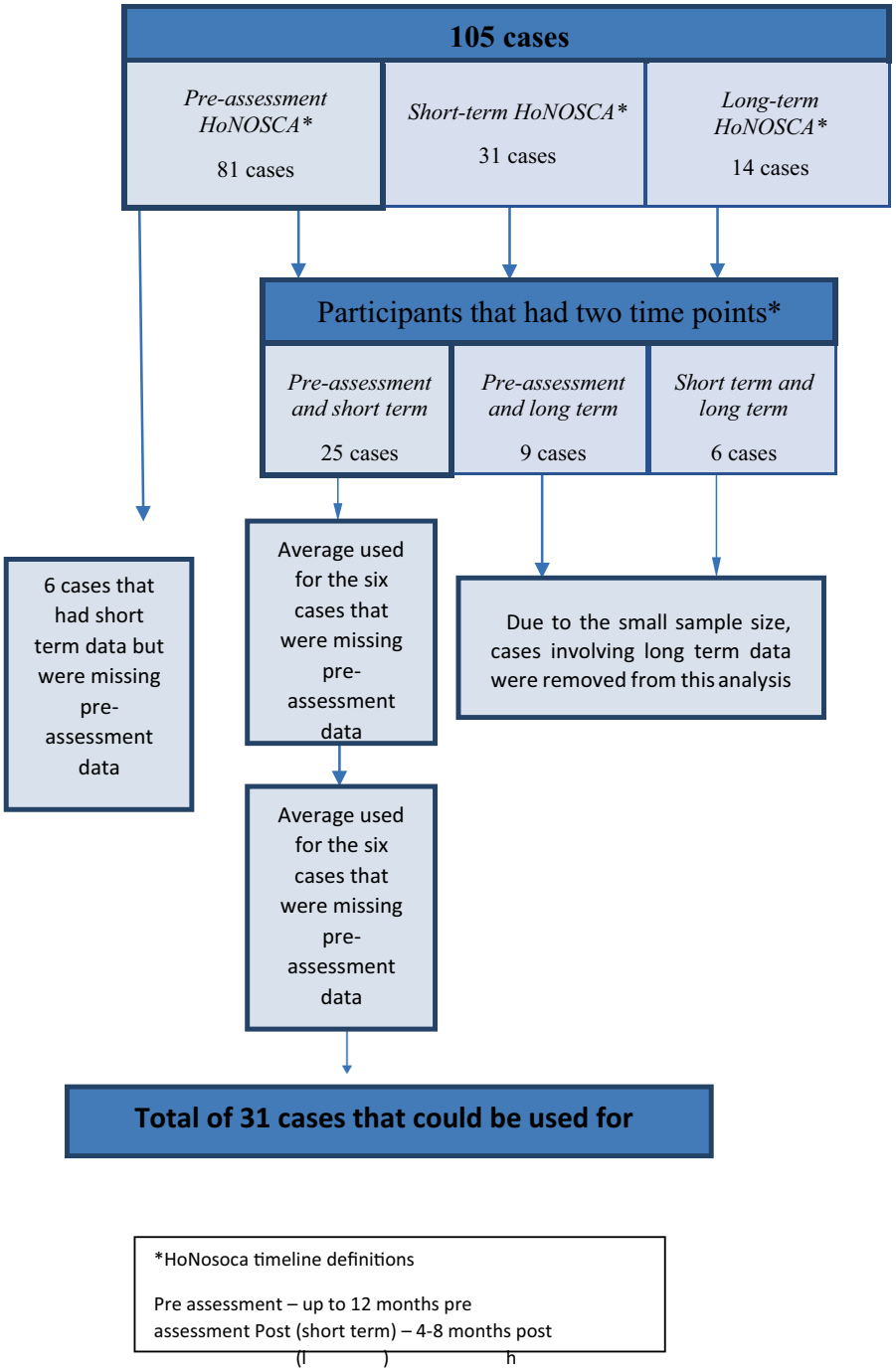

Fig. 1 Flowchart of study participants

Table 1 Difference in Mean Values on HONOSCA Scales Before Assessment and at Short Term Follow Up (n = 31)

HONOSCA Scale	Before Assessment	After Report	Mean Difference	T *(df)*	*p* Value	*Effect size*
Disruptive, antisocial and aggressive behavior	2.16	1.84	0.32	1.67 (30)	0.11	
Overactivity, attention and concentration	1.97	2.00	-0.03	-0.19 (30)	0.85	
Non-accidental self injury	0.71	0.32	0.39	2.04 (30)	0.05*	0.12
Alcohol, substance/solvent misuse	0.26	0.23	0.03	1 (30)	0.32	
Scholastic and language skills	2.00	1.74	0.26	1.61 (30)	0.19	
Physical illness or disability problems	0.42	0.45	-0.03	-0.17 (30)	0.86	
Hallucinations and delusions	0.23	0.45	-0.23	-1.37 (30)	0.18	
Non organic somatic symptoms	0.68	0.71	-0.03	-0.18 (30)	0.86	
Emotional and related symptoms	2.71	2.29	0.42	2.15 (30)	0.04*	0.13
Peer relationships	2.19	2.00	0.19	0.97 (30)	0.34	
Self care and independence	1.10	1.32	-0.23	-1.23 (30)	0.23	
Family life and relationships	3.00	2.35	0.65	3.93 (30)	0.00**	0.34
Poor school attendance	1.32	0.87	0.45	2.45 (30)	0.02*	0.16
Total score	18.74	16.58	2.16	1.95 (30)	0.61	

*significance $p < 0.05$; **significant $p < 0.01$

Analysis

Stage 1

The HoNOSCA was utilised to identify change in the child's functioning.

Paired samples t-tests were run on 25 matched pairs to evaluate if there were any significant differences between scores on the HoNOSCA pre-intervention (defined as 0–12 months prior to completion of the report) and post intervention in the short term (defined as 4–8 months after report completion). Significance was set at $p \leq 0.05$. Six clients (19 percent of the short-term data responses) had HoNOSCA data at the 207 short-term post intervention time point but did not have pre-treatment HoNOSCA data. For this reason, an average score on each HoNOSCA scale was calculated, based on the 81 results available in the data set. These average scores were applied to the six clients without pre-treatment HoNOSCA data, and paired t-tests were completed including these averaged pre-treatment data points (total n = 31). This process was not repeated for the short-term data as the sample size was deemed too small to calculate reliable average scores.

Stage 2

Own Organisation clinician participants (n = 15) who referred clients for Occupational Therapy Sensory processing assessments were surveyed via Survey Monkey (see Supplementary Material for survey tool) regarding their experience of the assessment and feedback process. Data (n = 11) from these survey responses were analysed thematically. Thematic analysis (Terry et al., 2017) of *Own Organisation* participants qualitative survey feedback was undertaken as part of the process evaluation design. Process evaluations explore the implementation of an intervention, including contextual factors and experience of an intervention (Oakley et al., 2006). It drew on survey responses *Own Organisation* participants provided regarding their experience of the sensory assessment, the recommended interventions, the feedback process and the translation of the recommendations.

Results

Paired t-tests were run to determine whether there were any changes in HONOSCA scores between pre-assessment evaluation and at short-term follow up (4–8 months post report). Matched pairs were available for 25 clients at short-term follow-up. It was found that participant scores on "Problems with family life and relationships" significantly decreased from pre-assessment (M = 3, SD = 0.87), suggesting less difficulty at the time of follow up (M = 2.4, SD = 0.91, t (24) = 3.29, $p = 0.003$). The eta squared statistic (0.31) indicated a large effect size. Similarly, the combined section of "Impairment", comprised of scholastic or language skills and physical illness or disability problems, also significantly decreased from pre-assessment (M = 2.52, SD = 1.16), suggesting less difficulty at the time of follow up (M = 2.04, SD = 1.31, t (24) = 2.21, $p = 0.037$). The eta squared statistic (0.17) indicated a large effect size.

Due to the finding of significant results, further analysis was completed using the averaged scores for missing data in the pre-assessment HONOSCA data. Averaged scores were

Table 2 Difference in Mean Values on HoNOSCA Subscales Before Assessment and at Short Term Follow Up (n = 31)

HONOSCA Scale	Before Assessment	After Report	Mean Difference	T *(df)*	*p* Value	*Effect size*
Behaviour	5.10	4.39	0.71	1.80 (30)	0.08	
Impairment	2.42	2.19	0.23	0.78 (30)	0.44	
Symptoms	3.61	3.45	0.16	0.42 (30)	0.67	
Social	7.61	6.55	1.07	2.41(30)	0.02*	0.16

*significance $p < 0.05$

included for pre-HONOSCA scores for six clients. Using this method, matched pairs were available for 31 clients at short-term follow up. Tables 1 and 2 outline the significant results utilising averaged scores between pre-assessment data and short-term follow up (4–8 months after the report). The HoNOSCA subscales in which significant change was noted were Non-accidental self injury ($t = 2.04$, $p = 0.05$), Problems with emotional and related symptoms ($t = 2.15$, $p = 0.04$), Problems with family life and relationships ($t = 3.93$, $p = 0.00$) and poor school attendance ($t = 2.45$, $p = 0.02$. The HoNOSCA Social subscale which incorporates peer relationships, self-care and independence, family life and relationships and poor school attendance decreased from pre-assessment to post assessment ($t = 2.41$ $p = 0.02$). Effect sizes were calculated using eta squared, and moderate to large effect sizes were found for all results.

Qualitative Findings

Eleven clinician participants provided feedback using the Clinician Participant Questionnaire regarding the process and utility of occupational therapy assessment. A thematic analysis (Terry et al., 2017) was undertaken of the responses by the lead author and validated by the 2nd author. The responses were analysed with the emergence of the following themes:

Increased Client Self-knowledge and Awareness

Clinician participant respondents noted the occupational therapy input facilitated greater understanding for young people about how sensory input was impacting on them, providing an alternative understanding and also new avenues to self-regulate. As one clinician participant noted the sensory processing assessment.

"gave (the) young person (a) good understanding of their arousal continuum (clinician participant)".

Assessment Process

Participants reported positively on their experience of the assessment process which provided an alternative explanation for the difficulties a young person was experiencing. This contributed to an increased understanding of sensory processing and its relationship to daily functioning. The following comments represent common themes in the feedback from clinicians.

> "Both the process of the assessment and the feedback offered were helpful for both the adults and the child to develop a deeper understanding of how to support emotional regulation and capacity to focus"
> "Great to get another perspective"
> "Definitely helps in ways at looking at client's social relationships at school and how to manage them"
> "It was helpful to have another professional with a different, but still trauma-informed, 'frame' look at R and help add understanding to his behaviours/experience, and what might help him"

Value of Communication Approach

As demonstrated by the comments below the feedback process utilized by the occupational therapist was reported by participants as particularly helpful in guiding clinician and carer responses to the child. It led to an increase in understanding by teacher participants of the difficulties a young person was experiencing as well as the interventions and environmental adjustments that could be implemented to maximize a young person's functioning in the home and school environments.

The knowledge gained from the assessment and the feedback process was valued by clinician participants as shown in the following comments:

> Both the process of the assessment and the feedback offered were helpful for both the adults and the child to develop a deeper understanding of how to support emotional regulation and capacity to focus. It was also so helpful that the feedback provided was not pathologising and delivered in normalising and productive way.
> "The assessment and particularly (the) verbal feedback session assisted me to think more creatively about the range of sensory interventions available and ways to implement them into everyday activities and interactions".

Accessible Report Format

Several participants also spoke specifically regarding the value of the report that was provided at the conclusion of the feedback session. This report incorporated strategies and ideas for tools that arose during the feedback discussions as being the most appropriate for the particular home or school environment. One clinician commented that the occupational therapist:

> *Completed two reports for the client I referred, one for professionals and one for carers and the client. This was much appreciated as the second report used much simpler language and "lay-man term" explanations which the participants were able to access and understand.*

Specificity of Recommendations

Participants were asked to comment on the recommendations provided by the occupational therapist. The participants reflected on the utility of the recommendations being matched to the young person's culture, sensory processing needs and the environments in which the young person was residing or being educated. They also commented on the positive implementation of the recommendations, the engagement of young people in using the materials and the positive impact of the recommendations. The following comments are representative of the feedback.

> *This is a boy with speech and language difficulties so playing a musical instrument that uses the mouth seems appropriate, especially given he is an Aboriginal boy. He is also a boy who seeks proprioceptive input and the sack (body sock) addresses this need.*

Body socks are light, full body suits made from breathable lycra, that make it fun to move around while providing tactile and pressure feedback. through the touch receptors and proprioceptors. These have been specifically developed for children with sensory processing challenges.

Clinician participants described the following benefits of the occupational therapy assessment process:

> *"Specificity of recommendations for individual client very helpful"*
> *"Supported effective communication with client. Provided clear guidance around calming and soothing activities for client"*
> *The Theraband is used in class for the child to press his feet against to gain firm pressure and movement which provided resistance and provided sensory opportunity without distraction to others".*
> Theraband is thick elastic bands that provide a way to strengthen muscles.

Discussion

The outcome evaluation results found children who have experienced complex developmental trauma and received usual care through *Own Organisation* and also occupational therapy intervention informed by sensory processing assessments had improved functioning across a number of domains (family life and relationships as well as the degree of impairment experienced by the child participants in relation to scholastic skills, language skills, physical illness and disability). These findings were meaningful and supported by the literature (Purvis et al., 2013; Warner, Cook et al., 2014, Warner, Spinazzola et al., 2014; Finn et al., 2018). The largest positive impact as evidenced by the HoNOSCA results, was noted in the children's family life and relationships. Whilst this is an area of functioning and development focused upon by *Own Organisation* in regular interventions for the children in this study, there was the added impact of an increased understanding of the child's behavior by parents, carers and clinicians which came through feedback from the assessments.

In interpreting the results, it appeared that as carers obtained greater insight into their child's behaviour, their responses to their child's behaviour changed. The increased understanding of behavior by parents and carers assisted them to promote and implement co-regulation of physiological arousal with the child at home. This led to attuned caregiving as described by Eisenberg et al. (2005) and an experience of increased safety for the child. This was noted by two of the *Own Organisation* clinician participants as described in the Results section above.

There was change in children's attitudes towards school in the outcome evaluation (assessed using the HoNOSCA) with children's attendance at school having increased. This was not a stated aim of the intervention but a positive finding. Fewer signs of impairment (classified by the HoNOSCA as scholastic or language difficulty, physical illness or disability) were also noted.

In the process evaluation the respondents provided examples to indicate the positive changes as a result of increased understanding and awareness by the teacher and/or implementation of sensory strategies within the school environment. The recommendations regarding sensory information were also valued in the school environment as discussed by the clinician participants.

The results suggested that following intervention, children felt more able to attend school and were better able to learn. The children who received sensory assessments were also assessed by clinicians on the HoNOSCA as exhibiting less self-harming behaviour. This is consistent with the findings of Warner, Cook et al. (2014), Warner, Spinazzola et al., 2014) which found implementation of the SMART program

reduced internalising symptoms in traumatized adolescents. The mechanism behind this change is unclear, but it may be that the sensory interventions provided have been able to decrease the children's distress and dysregulation.

The intervention may also have provided the children with sensory-based alternatives to managing their distress. It is also possible that the children have developed improved physiological self-awareness following the intervention and this has resulted in improved affect regulation, sensory modulation and self care skills. This is consistent with Novak et al., (2012) and Warner, Cook et al. (2014), Warner, Spinazzola et al. (2014) who both found children demonstrated greater self-regulation post-intervention. One of the participants surveyed described the occupational therapy assessment and feedback process as it "gave young person a good understanding of their arousal continuum".

Similarly, children also exhibited decreased emotional and related problems and decreased social difficulties. As indicated in Table 1 & 2 the results indicated that children had less difficulty managing their emotional distress overall, less difficulty in caring for themselves and less difficulty relating to peers following the intervention. This supports the findings of (Purvis et al., 2013; Wan Yunus et al., 2015; Finn et al., 2018). The importance of attention to sensory processing elements and change of the environment to support sensory processing and modulation of the child has been found in other studies (Fraser et al., 2017; Novak et al., 2012; Warner, Spinazzola et al., 2014) to decrease physiological arousal, and increase feelings of safety and clearer strategies for implementation when distressed are resulting in calmer, more adaptive responses and behaviour for children and young people. Both the process of the assessment and the feedback offered were helpful for both the adults and the child to develop a deeper understanding of how to support emotional regulation and capacity to focus.

Limitations

One of the limitations of the study was a reduction in the completion of follow-up clinical measures. While most clients had a completed pre-assessment HoNOSCA (81 out of 105, 77%), only 25 of 105 clients (24%) had a completed HoNOSCA. Further exploration of the mechanisms contributing to the positive change that was reported on the HoNOSCA repeat measure is indicated as the increased knowledge of sensory processing and the use of sensory interventions appears associated with a significant improvement in young people's daily functioning.

Further, as this intervention was completed simultaneously with conventional *Own Organisation* intervention, it is not possible to separate the conventional *Own Organisation* intervention from the sensory assessment intervention.

Future Directions

This is one of the first studies to examine the effectiveness of a sensory processing assessment to inform an intervention with children who have experienced complex trauma in Australia. It is recommended that further studies of the use of sensory interventions be undertaken with this population. It would also be helpful to consider a future study that examines occupational therapy intervention in comparison to a control group. This would enable the examination of the results in light of maturation or history impacting on the validity of the findings.

Conclusion

The children involved in this study had all experienced significant complex trauma, impacting their relationships and functioning at home and school. A sensory processing assessment provided these young people, their carers and teachers with additional information contributing to environmental adaptations, such as the use of musical instruments, Theraband and a Body Sock, that were associated with improved functioning and behaviour. This study provided support for the inclusion of sensory assessment as a guide to assist carers and educators to create and adapt environments to support positive outcomes for children who had experienced complex trauma.

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Data Availability The data that support the findings of this study are available on request from the corresponding author.

Declarations

Ethics Approval Ethics approval was provided by La Trobe University Human Research Ethics Committee, ethics approval number HEC04. The procedures used in this study adhere to the tenets of the Declaration of Helsinki.

Consent to Participate Informed consent was obtained from all individual participants or from legal guardians for young people aged under 15 years, included in the study.

Conflict of Interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

Competing Interests The authors have no competing interests to declare that are relevant to the content of this article.

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