Effects of a sensory integration intervention on behaviours of students with Autism: engagement, social and emotional behaviours

by

Swati Phatak

Thesis
Submitted to Flinders University
for the degree of

Doctor of Philosophy

College of Education, Psychology and Social Work
November 2019

Table of Contents

List of Tables

List of Figures

Abstract

According to the Diagnostic and Statistical Manual - fifth edition (DSM-5), the diagnostic criteria for Autism Spectrum Disorder (ASD) includes difficulties with social interactions and communication, verbal and non-verbal, restricted and repetitive behaviours and atypical engagement with sensory feedback from the environment. These characteristics have a significant impact on classroom engagement for students with autism.

This study used a single-case, multiple-baseline design to evaluate the effect of a Sensory Integration Programme (SI intervention) on task-engagement, social interaction, and emotional behaviours for students with autism and intellectual disability in their first year at school. A repeated measures design using the Sensory Processing Measure (SPM) was used to evaluate the effect of the SI intervention on sensory sub-scales, such as Planning and Ideas, Body Awareness, Balance and Motion, Social Participation, Vision, Hearing, Taste, Smell, Touch and Total of all sensory processing scores.

The effect of the SI intervention was evaluated from two perspectives: (a) Data from direct observations were analysed using the Excel Package for Randomisation Tests version 2.1 (ExPRT), and (b) teacher perceptions were used to determine changes in the nine subscales from a Sensory Processing Measure (SPM). Data from direct observations were analysed and the findings indicated an overall large effect on task engagement, when the SI intervention implementation was supervised by expert occupational therapists, such as in 2013 (d = 1.04) and 2014(d = 2.57). There was a negative effect on student-initiated social interactions in 2012 and 2013, while having a large effect in 2014. The duration of emotional behaviours displayed a large effect in 2012, and a moderate effect in 2013and 2014. The frequency of emotional behaviours displayed a moderate effect (*d* = 0.56) in 2012 and 2014, with a small effect in 2013.SPM was completed at T0, T1 and T2 by the class teachers and analysed using repeated measures ANOVA. The repeated measures ANOVA results of the nine subscales indicated improved outcomes for six subscales in 2012, five subscales in 2013, and three subscales in 2014.

These findings indicate that a class-based SI intervention can be effective in improving task engagement and in reducing the frequency and duration of emotional behaviours for some children with autism and intellectual disability. The impact of SI intervention or of SI intervention in conjunction with specific communication and language-based intervention for improving initiation and maintenance of social interactions requires further investigation.

Declaration

I certify that this thesis does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any university; and that to the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is made in the text.

Signed...

Date....November 2019...

Acknowledgements

I would like to acknowledge my Principal Supervisor Dr Julie McMillan who has been my mentor and guide for the journey since the dissertation of my pilot project. She has guided me past multiple roadblocks in the course of my study. I would also like to acknowledge my Associate Supervisor Dr Karyn Carson, who gave me valuable technical input on statistical analysis, structure and form of writing.

I have received valuable assistance for using SPSS from Pawel Skuza, Dr Richard Draper for his professional expertise in editing the thesis and my colleagues Abirami Thirumanickam and Rajkumar Brij for their help with calculating R-IRD and using the ExPRT software, respectively.

I must acknowledge my family who has been instrumental in me reaching this stage in my life and career. I thank my parents who taught me to value hard work and education, and my parents in law who only ever wished me well in my ventures.

I thank my husband Sanjay and my children Siddharth and Sai, who inspire me and from whom I draw endless emotional strength and the will to keep going. I thank my siblings Sulakshana and Shrish with whom I shared some madcap dreams that we all have worked hard to achieve. I thank the many friends and colleagues from whom I kept learning at every juncture of my life.

I acknowledge the leadership and staff of Modbury Special School, who were gracious in their participation of my project. And last, but not least, I am obligated to the countless students over the years without whom this spark would not have been lit.

My most humble thanks to all of you who made the completion of this journey possible.

I acknowledge the websites by Purdue University (2013) and Alliant International University (2014) for using their resources in formatting this work according to APA 6^{th} edition requirements.

I acknowledge that I am a recipient of RTP support and the Australian Government Research Training Program Scholarship has contributed to the completion of this thesis.

Glossary

ACC – see Anterior cingulate cortex

Anterior cingulate cortex – a frontal part of the brain involved in formation and processing of emotion, learning, and memory

AI – see Anterior insulate

Amygdala – a diamond-shaped area of grey matter situated inside each half of the cerebrum involved in processing of emotion

ANOVA – analysis of variance, a statistical test

Anterior insulate – a part of the cerebral cortex folded deep and involved in consciousness and emotions related to basic survival needs

ASD – see Autism spectrum disorders

Asperger's syndrome – pervasive neurodevelopmental disorder listed in DSM-IV distinguished from autism by average or higher IQ

Autism – see Autism spectrum disorders

Autism spectrum disorders – pervasive neurodevelopmental disorder listed in the DSM-5, also known as autism

Axon – a long slender thread like projection of a neuronal cell. It works like a transmission line of the nervous system

Axonal bundles – numerous axons bundled up to form nerves

Brain stem – the central trunk of the brain including the medulla oblongata, pons, mid-brain and continuing into the spinal cord

Cerebellum – a part of brain situated at the back that coordinates and regulates muscular activity

CNS – central nervous system

Cortex – the outer layer of the cerebrum formed of neuronal grey matter

Corpus callosum – a broad band of nerve fibres joining the two hemispheres of the brain

DD – developmental delay

DDA – Disability Discrimination Act, part of Australian federal legislation

DECD – Department of Education and Child Development, part of the Government of South Australia

Diagnostic and Statistical Manual of Mental Disorders – a manual that contains definitions and diagnoses of disorders, currently in its fifth edition, which is commonly abbreviated as DSM-5

Discreet trial training – a method of teaching new response to a stimulus using adult-directed instructions, strong reinforcement, clear contingencies, and several repetitions

DSM – see Diagnostic and Statistical Manual

EBA – see Extrastriate body area

EBP – evidence-based practices

Extrastriate body area – a part of the visual cortex involved in the perception of body parts and shape of human body

FFA – see Fusiform face area

*f*MRI – functional magnetic resonance imaging

Frontal lobe – twin lobes in the front of the brain controlling learning, personality, behaviour and voluntary movement

Functional behaviour analysis – a procedure developed to ascertain the function of disruptive or challenging behaviours

Fusiform face area – a part of the occipital and temporal lobes involved in processing faces

Fusiform gyrus – a part of temporal and occipital lobes, hypothesized to recognize shape, body, face and word

Hippocampus – the long ridges situated on the floor of each lateral ventricle of the brain, also considered to be the centre of emotion, memory, and the autonomic nervous system

Hypothalamus – a part of the brain situated behind the forebrain that coordinates the autonomous nervous system and the activity of the pituitary gland

ID – intellectual disability

IFG – see Inferior frontal gyrus

Inferior frontal gyrus – somatosensory part of the brain, associated with Inferior parietal lobule and Anterior insula

Inferior parietal lobule – premotor cortex part of the brain, associated with Inferior frontal gyrus and Anterior insula

IPL – inferior parietal lobule

Kata techniques – set of detailed choreographed movement patterns performed solo or with a partner in martial arts

Limbic system – a complex network of nerves in the cortex controlling basic emotions, drives, instinct, and mood

MNS – mirror neuron system model

MRI – magnetic resonance imaging

NAP – non-overlapping pairs of data points

Nucleus accumbens –a region in the basal forebrain in front of the hypothalamus, involved in processing of attention, motivation, aversion and reinforcement learning

Occipital lobe – two lobes situated at the back of the head above the cerebellum

OFC – see Orbitofrontal cortex

Orbitofrontal cortex – front part of the brain involved in cognitive processing of making decisions

Parietal lobe – twin lobes situated at the top of the head involved in receiving and correlating sensory information

Planum temporale – cortical area of the brain just behind the auditory cortex that forms the heart of one of the most important functional areas for language

PC – see Precuneus

PCC – see Posterior cingulate cortex

PDD – pervasive developmental disorders

PFC – see Prefrontal cortex

pica – a desire to eat inedible material

PMC – see Premotor cortex

Posterior cingulate cortex – a part situated deep within the midline of the brain with highest activation patterns and blood flow

Precuneus – a part of the brain situated deep between the two cerebral hemispheres involved in the mental imagery of self, episodic memory, and visual-spatial imagery

Prefrontal cortex – a part covering the front of the frontal lobe responsible for short-term memory and a mental map of information not immediately visible

Premotor cortex – a part of the cortex situated within the frontal lobes involved in generating of neural impulses that control physical movements

PRPP – perceive, recall, plan, perform stage two cognitive task analysis

SCED – single case experimental design

SDAC – survey of disability, ageing, and carers

Sensory integration programme – a programme developed on the basis of Ayres' Sensory Integration theory

Sensory modulation disorder – a type of Sensory processing disorder that relates to the brain's ability to respond appropriately to stimulus and maintain optimal and stable arousal levels (alertness)

Sensory processing difficulties – difficult or challenging behaviours arising from Sensory processing disorder, such as seeking, avoiding, poor registration of stimuli, hyper sensitivity, and hypo sensitivity

Sensory processing disorder – a complex neurological disorder experienced by children and adults in which they have difficulty in organising and integrating sensory information

SI – sensory integration

SI intervention – see Sensory integration programme

SLD – speech and language disorder

SMD – sensory modulation disorder

SPD – see Sensory processing disorder

SPM – the Sensory Processing Measure which is a diagnostic tool to measure sensory scores and indicates ‘some difficulty’ or ‘definite difficulty’ in individual sensory domains

SPSS – Statistical Package for the Social Sciences

STS – see Superior temporal sulcus

Superior temporal sulcus – a part of the brain involved in social perception, joint attention, and theory of mind

Teacher registration board – part of South Australian government that upholds education legislation by regulating the teaching profession

Temporal gyrus – a fold or ridge on the temporal lobes of the brain; there are three types, namely: superior temporal gyrus responsible for auditory processing; middle temporal gyrus responsible for recognising familiar faces, estimating distance, and making sense of words while reading; and inferior temporal gyrus responsible for visual perception

Temporal lobe – twin lobes situated behind each of the temple areas of the head involved in processing of speech

TRB – see Teacher registration board

VS – a part of the brain involved in reward systems and motor functions

VS – see Ventral striatum

Chapter 1

Introduction

Diagnosis of autism spectrum disorder (ASD)

Children with Autism Spectrum Disorder (ASD) have unique patterns of processing sensory information that often present significant challenges and act as barriers to developing adaptive behaviours, which can lead to difficulties for optimal learning in the classroom (Baker, Lane, Angley, & Young, 2008; Janzen, 1996, p. 28; Lane, Young, Baker, & Angley, 2010). Ashburner, Ziviani, and Rodger (2008); Hilton et al. (2007); Miller, Schoen, Coll, Brett-Green, and Reale (2005) have established association between sensory processing difficulties and behaviour among children with autism. Children who have low arousal levels and who tend to habituate to repeated sensory stimuli are observed to have more difficulties with social communication and interactions, as well as displaying increased instances of repetitive behaviours (Hilton et al., 2007; Miller et al., 2005; Parham et al., 2011). Individuals who present with sensory processing difficulties also may have some or all of the following: maladaptive behaviours, anxiety, self-absorption, antisocial behaviours, unusual perseverance of interest, activity or thought, as well as hyper-focusing of attention (Baker et al., 2008; Liss, Saulnier, Fein, & Kinsbourne, 2006). In addition, it has been found that children with processing difficulties in the auditory, tactile, and movement sensory systems also had problems such as inattention, hyperactivity, oppositional behaviours, and underachievement in academic pursuits (Ashburner et al., 2008).

The Diagnostic and Statistical Manual-5 (DSM-5) (American Psychiatric Association, 2013) indicates two broad areas of deficit that individuals with autism experience: 1) difficulty with social communication and impaired social interaction, and 2) restricted and repetitive patterns of behaviour, interests, and activities (DSM-5). Each of these areas of deficit has a different impact on learning. The first relates to difficulty with social communication and interaction, including deficits in social-emotional reciprocity, and is characterized by an atypical approach to people for the purpose of communication, difficulty with reciprocal conversation, reduced sharing of interests, and difficulties initiating and responding to interactions. Autistic individuals often have difficulties with non-verbal behaviours used for communication, such as eye contact, body language, gestures, and facial expressions. Other behaviours that occur as a result of social communication and interaction difficulties include a failure to establish, maintain, and understand relationships, failure to adjust own behaviour to that appropriate for a specific social context, a lack of imaginative play, and a lack of sharing interests with friends. The second criterion – restricted and repetitive behaviours – includes stereotyped repetitiveness of motor movements, use of objects, and speech; rigid adherence to routines; ritualized patterns of verbal and non-verbal behaviour; fixated interests in subject areas or objects with atypical intensity; and hyper- or hypo-reactivity to sensory stimuli within the environment (American Psychiatric Association, 2013). The DSM-5 also specifies that these symptoms of difficulty with social communication and impaired social interaction, and restricted and repetitive patterns of behaviour, interests, and activities have to be present from a child’s early developmental period. Symptoms should be of an intensity to cause significant social difficulties, continue in occupational opportunities that impact long-term quality of life, and, importantly, they may not be explained by intellectual disability and global developmental delay (American Psychiatric Association, 2013).

The impact of difficulties associated with autism on individuals and in turn on communities is significant and is discussed in the following examination of surveys conducted by the Australian Bureau of Statistics.

Prevalence of ASD

In 2016, the prevalence of autism in the USA was reported to be 1 in 68 (Christensen et al., 2016). In Australia, the Survey of Disability, Ageing, and Carers (SDAC) indicated an increasing occurrence of autism for children between the age range of 6 through 14 years: in 2014, 1 in 61.5; in 2009, 1 in 91; in 2006, 1 in 160 (Australian Bureau of Statistics, 2014). The survey in 2009 (Australian Bureau of Statistics, 2009) reported 64,600 children between 6 through 14 years of age diagnosed with autism under the DSM-4. The survey in 2014 reported 115,400 people diagnosed with autism (a reported 79% increase) (Australian Bureau of Statistics, 2014), 164,000 people in 2015 (a reported 42.1% increase) (Australian Bureau of Statistics, 2015). The latest figures of the prevalence reported are between 1.5 % to 2.5 %, or 1 in 40-65 (Randall et al., 2016). The increases in reported occurrences of autism in Australia are concerning, although some of the occurrences may be attributed to the widening of diagnostic criteria since the introduction of the DSM-5 in 2013, to differences in study methodologies, and to increased awareness.

According to the SDAC survey, in 2016, almost 97 % of children within the ages of 6 through 14 years with autism experienced some sort of educational restriction, with 48% needing to attend a special school or a special class, and a small number unable to attend school due to their difficulties (Australian Bureau of Statistics, 2015). Many children with autism need a high level of support to attend school, with 42% needing a counsellor or disability support person within mainstream education and 56% requiring special tuition. Unfortunately, census data indicated that 44% of children with autism failed to receive the required additional support (Australian Bureau of Statistics, 2015).

The top three types of difficulties experienced by students with autism at school were reported as: (a) communication difficulties (51%); (b) learning difficulties (60%); and (c) fitting in socially (63%). The SDAC survey also indicated that the highest levels of support needed were with: mobility (46%), communication (51%), and emotional and cognitive tasks (42%) (Australian Bureau of Statistics, 2015). Moreover, only 41% of people with autism participated in the workforce compared to 83% of people without disability (Australian Bureau of Statistics, 2015).

Between 13% and 30% of children with autism also present with challenging behaviours (Emerson, 2001; Hill & Furniss, 2006; Matson, Sipes, Fodstad, & Fitzgerald, 2011; McDougal & Hiralall, 1998), especially those children with limited social and communication skills (Borthwick-Duffy, 1996; Chiang, 2008; Koegel, Koegel, & Surratt, 1992). Challenging behaviours in relation to autism and intellectual disability will be discussed in the following subsection. For children with autism, 50% to 70% are also found to have intellectual disability (Matson & Shoemaker, 2009) with correlation between lower intellectual quotient and higher autistic behaviours, as well as lower intellectual quotient and higher challenging behaviours (Matson & Shoemaker, 2009). Children with a diagnosis of autism, which also includes an earlier diagnosis of Asperger’s syndrome under the DSM-5, often present with significant difficulties in on-task behaviour, a paucity of social skills (such as co-operation, assertion and self-control), and difficulties with emotional regulation, all skills that are requisites for functioning effectively in the classroom (Macintosh & Dissanayake, 2006).

Significance of study

The latest Australian data from the SDAC survey indicated that 1 in 61.5 school-age children is diagnosed with autism (Australian Bureau of Statistics, 2014, 2015). The National Disability Insurance Agency (NDIA) disburses financial assistance to people with disability and their families and carers through the National Disability Insurance Scheme (NDIS). This lifelong support is aimed to build capacity and skills. Data for school-age children receiving specialist support funding indicated that 50% to 60% of the group are children with a diagnosis of autism and intellectual disability (NDIA, 2017). Given that these children will be part of the education system from preschool to high school and possibly later in supported employment, autism should be examined for its full scope of difficulties and their implications for education. More specifically, understanding the nature and characteristics of autism and implementing relevant interventions is essential to improving educational outcomes for these children.

Difficult behaviour among children diagnosed with autism usually includes self-injury, property destruction, pica (desire to eat inedible material), stereotyped movements, defiance, tantrums, and disruptions (Horner, Diemer, & Brazeau, 1992; Macintosh & Dissanayake, 2006; Matson et al., 2011). Between 13% and 30% of children with autism have been reported to engage in problem behaviours that require intervention (Emerson, 2001; Hill & Furniss, 2006; Matson & Jang, 2014; Matson & Shoemaker, 2009; McDougal & Hiralall, 1998), particularly those children with limited social and communication skills (Borthwick-Duffy, 1996; Hodgson, Freeston, Honey, & Rodgers, 2016; Koegel et al., 1992). In addition, parents and teachers of children with autism report deficits in social skills, particularly co-operation, assertion, and self-control (Macintosh & Dissanayake, 2006). Difficulty in communication and a lack of social skills combined with other problems (such as being distracted easily, appearing disorganised and an inability to orient oneself in terms of physical position or time) interfere with the student's ability to focus and function in the classroom (Ashburner et al., 2008; Goodman & Williams, 2007; Janzen, 1996). Such behaviours also affect the emotional wellbeing of the students, as they know they are different and they know they are experiencing unusual difficulties compared to their peers (Mazzone et al., 2013; Strang et al., 2012; White, Oswald, Ollendick, & Scahill, 2009). Therefore, to improve the outcomes and experiences of children with autism in schools, social and emotional difficulties that interfere with student engagement must be addressed.

Research indicates that sensory processing difficulties could play a significant role in the three core difficulties associated with autism: social interaction, communication, and restricted repetitive behaviour patterns (Chen, Rodgers, & McConachie, 2009; Lane et al., 2010). Restricted and repetitive behaviour patterns and unusual preoccupation with the sensory properties of a stimulus is one of the two criteria for autism (APA, 2013). Dunn (1997) demonstrated that atypical sensory processing in children with autism influenced their observed behaviours and could be classified as sensory seeking or sensory avoiding, hyper-reactive (over reactive) or hypo-reactive (under reactive) to sensory stimuli. An individual's sensitivity to stimuli would depend on whether he or she registered the stimulus as soon as it was presented, do not register it or register it in a delayed manner (Dunn, 1997). A child with low registration of stimuli would appear uninterested in a task and may result in either overlooking the task entirely or appear to have repetitive behaviours till he or she registered the task enough to engage and complete the task. Similarly, an over-sensitive or over-reactive child may avoid the sensory stimulus because it hurt or indulge in some other repetitive behaviours to block out the intrusive stimulus (Dunn, 1997; Dunn, Myles, & Orr, 2002). Students struggling to transfer interest or attention during transitions are prone to over-focusing on one stimulus or low registering of the new stimulus (Ashburner et al., 2008). The over-focusing of attention among children with autism is thought to be led by a preference for static and predictable stimuli over changing stimuli, which of course would be a challenge in a dynamic classroom or in a social interaction with peers (Landry & Bryson, 2004; Rinehart, Bradshaw, Moss, Brereton, & Tonge, 2001).

Several studies have estimated that 82% to 97% of children with autism have Sensory Processing Disorder (SPD) in some form or another (Baker et al., 2008; Leekam, Nieto, Libby, Wing, & Gould, 2007; Marco, Hinkley, Hill, & Nagarajan, 2011b; Rogers & Ozonoff, 2005; Tomchek & Dunn, 2007). The sensory processing difficulties reported were auditory processing, visual responding, rough playing, climbing in an uncontrolled manner, not responding to verbal input, unusual focus on inspection of hands and so on. It was observed that children with such sensory processing difficulties experienced difficulty in adaptive behaviours. Sensory processing difficulties could also play a role in the adoption of restricted and repetitive behaviour patterns, as well as being associated with academic underachievement (Ashburner, Rodger, Ziviani, & Hinder, 2014; Gal, Dyck, & Passmore, 2010; Tomchek & Dunn, 2007). Several of the restricted and repetitive behaviours can pose varying degrees of challenge due to the risk of injury to self or others. Typical challenging behaviours associated with autism include self-injurious behaviour such as hitting, biting, head banging, and self-stimulatory behaviours such as flapping hands, humming or buzzing sounds, repetitive movements of head, rocking, and bouncing (Horner, Carr, Strain, Todd, & Reed, 2002; Macintosh & Dissanayake, 2006; Reichle, 1990). When sensory processing difficulties begin to impact on daily lives and routines for children with autism, due to their intensity and frequency, a diagnosis of sensory processing disorder (SPD) is made (Miller, Anzalone, Lane, Cermak, & Osten, 2007).

The afore-mentioned behaviours arising from SPD cause concern when they interfere with the child’s social interaction, classroom engagement and academic achievement (Ashburner et al., 2008). Such behaviours interfere with initiating and sustaining interactions with others. This becomes an issue when these children interact in society, particularly when beginning school, where they have to meet increased demands for acceptable classroom behaviour. Expected classroom behaviours include a capacity to listen, follow instructions, to keep distractive behaviour to a minimum, and to stay focused on task (Westwood, 2004). Children are also expected to cope with the social demands of being in the classroom with peers and staff members.

In a special school for students with autism and intellectual disability, the teacher has to manage behaviours including short attention span, difficulty in focusing attention on a task, difficulty in processing instructions and difficulty in transitions between activities, location or staff (Ashburner et al., 2014; Ashburner et al., 2008; Janzen, 1996). SPD might be a contributing factor underlying or exacerbating these behaviours. Therefore, understanding how sensory processing functions in autism and its manifestation in behaviour could help teachers to plan effective strategies to avoid or minimise a crisis, recover from a crisis, and deliver the curriculum effectively. Supporting the teacher to understand the sensory needs of their students and to implement the sensory strategies in the classroom would assist the teacher to increase student's task engagement, to improve the frequency and quality of social interactions with their peers, and to manage or decrease the frequency and duration of their students' emotional behaviours. Since learning can be achieved only when a student is engaged with a task and is not distracted by environmental stimuli, learning is more difficult for students with autism. Education for students with autism and other disabilities is facilitated with appropriate teacher training, along with accommodations and adjustments for individual students supported by necessary policy.

Legislation for disability education

Until the 1970s, legislation was not in place to support inclusion in education and society for children diagnosed with autism or who exhibited signs of autism (Scott, Clark, & Brady, 2000a). During the 1970s a movement towards the inclusion of individuals with disability in education gained traction through the introduction of important legislation. Examples of such legislation include: the Education for all Handicapped Children, Public Law 94-142/99-457/101-476 (1975) in the United States of America, the Disability Discrimination Act (1995) from the United Kingdom and The Salamanca Framework for Action, 1994, Article 2 in the United Nations

Educational, Scientific and Cultural Organisation (UNESCO). The Education for all Handicapped Children Act (1975) in the USA led to the Individuals with Disabilities Education Act (1990), and the Disability Discrimination Act (1995) led to the Equality Act (2010) in the UK. Both the US and UK examples mandated equal access to education in the mainstream, while the UNESCO article stated “Regular schools with inclusive orientation are the most effective means of combating discrimination, creating welcoming communities, building an inclusive society and achieving education for all” (UNESCO, 1994, p. ix).

The rights of people at risk of marginalisation and under-achievement also became protected by Australian legislation through the Education Act (1989), the Anti-Discrimination Act (1991), the Disability Services Act (1992) and the Disability Discrimination Act (1992). In Australia, the Disability Standards for Education (2005) within the parent Disability Discrimination Act reauthorised in 2005, required education systems to embrace the principles of equal opportunity in enrolment, participation, curriculum development, accreditation and delivery of curriculum, student support services and to eliminate harassment and victimisation. The Disability Standards for Education (2005) state “It is unlawful for an education provider to discriminate against a person on the grounds of the person’s disability or a disability of any of the person’s associates by developing and accrediting an alternate curricula or training courses having a content that will either exclude the person from participation, or subject the person to any other detriment” (Disability Discrimination Act, 2005, p. 3). It further recommends “to put in place reasonable adjustments to eliminate, as far as possible, discrimination against those persons” (Disability Discrimination Act, 2005, p. 4).

In South Australia, the Australian State in which this study was conducted, these national standards continue to be upheld by the Department of Education and Child Development (DECD), embodied in its Students With Disability policy (2005-2011) (DECD, 2017). This policy has been reviewed and updated regularly, with the current version in place from 2014-2018. According to the Students With Disability policy, educators are required to provide equal opportunity to access education with reasonable adjustments to the physical environment, modification of curriculum and instructional adjustment (DECD, 2017, p. 5). The Teacher Registration Board (TRB) of South Australia upholds education legislation by regulating the teaching profession through maintaining appropriateness of teacher education courses, professional development and required professional standards (Legislation, 2004). Thus, in order to effectively meet their responsibilities, teachers are required to understand, adjust to, and accommodate the needs of students with a disability.

History of disability education

Experienced practicing special education teachers know firsthand the highly individualistic nature of autism. No two students are alike in their behaviour and presentation of difficulties, creating a diverse learning profile (APA, 2013). The term “Autism Spectrum Disorder” is used to cover the vast range of intellectual abilities, skills, and language proficiency observed within individuals and groups (Hill & Frith, 2003). Along with differing abilities, there may be a variety of difficult behaviours among students. Since autism was first clinically documented in 1943, different strategies have been used to manage difficult behaviours (Scott et al., 2000a; Scott, Clark, & Brady, 2000b).

Before 1990, aversive consequences were not unknown in the management of problem behaviours. Since then, there has been a change in the management of difficult behaviours, with the inclusion of stimulus-based instruction-based procedures, extinction-based, reinforcement-based, punishment-based and systems change (Horner et al., 2002; Horner et al., 1992). The stimulus-based interventions include modifications for curriculum, instructional design, social organisation, schedules and physical environments (Horner et al., 2002). Some of the instruction-based procedures include Applied Behaviour Analysis (ABA) (Baer, Wolf, & Risley, 1968) and Discrete Trial Training (DTT) developed by Lovaas in the 1980s (Lovaas, 1987). These have intervention components such as the use of discriminative environmental stimuli, instruction, and consequences. Though these procedures may have a sensory component to the use of stimuli, the aim is not to regulate or modulate internal sensory systems. Rather the behavioural paradigm uses discriminative stimuli to occasion or evoke the occurrence of desirable behaviour. Such intervention strategies often address the issue of hyper- or hypo-sensitivity of the child by making environmental modifications or making adjustments to the teaching practice to suit the child’s needs. However, these strategies do not focus on development of the child’s ability to cope with classroom challenges due to their sensory processing difficulties by teaching them to process the sensory stimuli with controlled delivery.

Based on Dr. A. Jean Ayres’ Sensory Integration theory, a sensory integration programme (SI intervention) is a sensory stimulus-based intervention (Ayres, 1972, 1980). SI intervention proposes modulation (control or arousal) of behaviour through controlled delivery of sensory stimuli and adaptive response of the child. It is important that the child initiates the response to the sensory stimuli and the response should be sustained over a period as the stimulus becomes increasingly complex. Other interventions based on sensory stimuli include the Sensory Diet (Wilbarger & Wilbarger, 2002) which offers delivery of a sensory stimulus at different times of the day, alternating with routine tasks, and the “Alert” programme (Williams & Shellenberger, 2002) which incorporates developing awareness of internal arousal states along with some cognitive training aimed at learning to regulate behaviour. The latest sensory-based intervention addresses interoception, the visceral sense of self that reflects the physiological condition of all the tissues of the body (Craig, 2003; Wiens, 2005). These sensory programmes are typically developed and implemented by trained personnel, such as occupational therapists, and may require specific equipment. Currently, support services are limited in their capacity to deliver such sensory-based interventions among school children aged between 5 and 20 years (Australian Bureau of Statistics, 2015), particularly given the limited evidence to support potential educational benefits to learners with autism.

Effects of autism

In a typically developing human body, the central nervous system (CNS) works automatically to take in the stimuli from the environment and then helps the brain to adapt its response. The human body is able to survive in its environment through a process of sensory inputs from its surroundings, processing of this input in different cortical areas of the brain and lastly, organising an adaptive response that modulates appropriate behaviour to the stimulus (Humphry, 2002). The body makes sense of its environment through its senses: taste (gustatory), smell (olfactory), touch (tactile), sight (visual), hearing (auditory), sense of position and movement of body parts such as limbs, trunk and head(proprioception or kinesthetic); sense of movement, sense of balance and sense of body in space (vestibular); and interoception (internal physiological awareness) (DuBois, Ameis, Lai, Casanova, & Desarkar, 2016; Garfinkel et al., 2016).

In autism, the sensory systems do not function in a typical synchronised manner and this may reflect in different behaviours such as not registering presence of the stimulus, ignoring the stimulus by avoidance behaviour or over-reacting to the stimulus (Ayres, 1978; Davies & Gavin, 2007). Due to their sensory processing difficulties, children with autism struggle to make sense of their surroundings and have difficulty in adapting behaviour to their surroundings (Ayres, 1978, 1980; Davies & Gavin, 2007). This creates challenging situations in a classroom context as the behavioural demands on students may be beyond their capacity.

Students are expected to meet basic social requirements such as maintaining focus for extended periods, listening to instruction, attending to and making sense of visual cues, refraining from aggressive and antisocial behaviours; and to meet these requirements with minimal emotional behaviours. Thus, teachers need to know how to respond and adapt to the varied sensory needs of students in order for them to participate and progress in their education.

Ayres' Sensory Integration® (Smith Roley, Mailloux, Miller-Kuhaneck, & Glennon, 2007) is an intervention that engages the child in increasingly complex sensory activities that in turn support the child to organise their own behaviour and participate in their daily lives in an increasingly satisfactory manner (Ayres, 1980). A sensory integration programme or therapy typically targets the central nervous system through activities designed to increase or decrease internal arousal, improving sensory discrimination, motor planning and postural control (Miller, Anzalone, et al., 2007). This can impact emotional states through internal processes, rather than through specific external environmental controls.

Researching sensory integration

There have been some efforts to examine the efficacy of interventions and potential benefits of programmes based on Ayres' Sensory Integration® (Smith Roley et al., 2007) theory such as Bonggat and Hall (2010); Case-Smith (2002); Case-Smith and Bryan (1999); Devlin, Healy, Leader, and Hughes (2011); Devlin, Leader, and Healy (2009) and so forth. The findings of such studies have been contested in peer-reviewed literature through several systematic reviews and meta-analyses (Case-Smith & Arbesman, 2008; Case-Smith, Weaver, & Fristad, 2014; Lang et al., 2012; Leong, Carter, & Stephenson, 2015; May-Benson & Koomar, 2010; Ottenbacher, 1982).

The literature review included in Chapter 2 examined studies relevant to interventions based on the sensory integration theory and involving participants with autism as opposed to some that involve participants with other diagnoses. For the present study, twenty studies were identified in the academic literature that tested the effects of sensory integration intervention. These studies used interventions based on A. Jean Ayres' Sensory Integration® (ASI®) (Smith Roley et al., 2007) theory to varying degrees, and examined the effect of a SI intervention on the social and emotional behaviour of participants that included self-injurious and self-stimulatory behaviours. Most of the studies included a small number of participants, did not replicate their results or were in a clinical setting, and targeted self-stimulatory and self-injurious behaviours.

The literature review undertaken for this study identified the need for a rigorous design that allowed for replication in order to study the effect of a SI intervention on the social and emotional behaviour of students with autism, aiming for a change in the length of engagement and resulting impact on learning. The outcomes of intervention had to meet basic behavioural requirements in order to improve student engagement and learning in a classroom, as are recognised by classroom observations from practice, student voice and teacher perspective (Ashburner et al., 2008; Boutot, 2007; Humphrey & Lewis, 2008; Lindsay, Proulx, Scott, & Thomson, 2014). Some behaviours to be addressed were identified for this study. First, it was necessary to reduce the disruptive emotional outbursts whenever a student was faced with a task demand or challenging situation, such as a transition between learning area or activity, or a change in routine, staff, or environment. Second, it was important that each student remained focused on the task, instead of reacting to every stimulus in the environment, for example, background noise and movement. Third, it was important to determine if the social behaviours of each student could be improved to reduce the relative isolation in which he or she existed.

Research rationale and objectives

The incidence of SPD among children with autism is between 82% and 97% (Ashburner et al., 2008; Baker et al., 2008; Kientz & Dunn, 1997; Lane et al., 2010), which means there is a need for effective treatment. As previously noted, there is a paucity of experimental evidence in the literature and it was therefore necessary to further investigate the potential of sensory-based interventions to support learners with autism. This study aimed to investigate the effectiveness of a SI intervention in a classroom setting on the social interactions, emotional behaviour, and task engagement of 5 to 6 year old children with autism and intellectual disability in a special school setting.

Research questions

A. Jean Ayres (1979) proposed that children with autism, who may also have learning disabilities, could be helped with sensory integration intervention. Since then, an effort has been made to study its effect mostly on self-injurious and self-stimulating behaviours and more recently on family participation goals, but not on its impact on classroom behaviours, which are influenced by the characteristics of autism.

For learning to occur, a basic requirement is that a student engages with a task, academic or otherwise. Task engagement was the first variable to be measured. The second variable to be measured was difficulty in social interactions, as it is one of the characteristics of autism (APA, 2013). The final focus of the study was on the emotional behaviour of the student when faced with the different challenges in a typical school day. The emotional behaviours mentioned in this study were behaviours such as crying, withdrawing, non-participation, aggression to others, destruction of task materials and/or furniture and occasionally self-injury, which prevented the child from positive interactions and classroom engagement.

The study investigated the following questions:

1. What effect did classroom-based implementation of a SI intervention for children with a dual diagnosis of autism and intellectual disability, in their first year of schooling, have on duration of task engagement in the classroom?
2. What effect did classroom-based implementation of a SI intervention for children with a dual diagnosis of autism and intellectual disability, in their first year of schooling, have on frequency of student-initiated social interactions during school-yard free play opportunities?
3. What effect did classroom-based implementation of a SI intervention for children with a dual diagnosis of autism and intellectual disability, in their first year of schooling, have on the frequency of emotional behaviours in a routine day at school?
4. What effect did classroom-based implementation of a SI intervention for children with a dual diagnosis of autism and intellectual disability, in their first year of schooling, have on the duration of emotional crises in a routine day at school?
5. What effect did classroom-based implementation of a SI intervention with a dual diagnosis of autism and intellectual disability, in their first year of schooling, have on sensory processing ability including balance and motion, body awareness, hearing, planning and ideas, social participation, taste, touch, vision, and the total of all subscales scores?
6. Were there any relationships between outcomes of SI intervention for task engagement, student-initiated social interactions, frequency and duration of emotional behaviours and for sensory processing abilities such as balance and motion, body awareness, hearing, planning and ideas, social participation, taste, touch, vision, and the total of all subscales scores?

These questions are addressed through the following chapters. Chapter 2 reviews the literature about the neuropathology of autism and networks in common with intellectual disability and their impact on student behaviour. Chapter 2 also reviews the literature about sensory integration intervention. Chapter 3 discusses the method and the data collection process. Chapter 4 discusses analysis of data and findings. Chapter 5 discusses the findings, their implications for practice, limitations of the study, future considerations and overall conclusions.

Chapter 2

Literature Review

This literature review discusses characteristics of Autism Spectrum Disorder (ASD). The term “autism” is used instead of its diagnostic label (Autism Spectrum Disorder) for sake of convenience. The literature review then follows with a detailed discussion of Sensory Processing Disorders (SPD) within the different sensory systems, as experienced by children with autism. The sensory systems under discussion will be the visual system, vestibular system, auditory system, olfactory, gustatory, and tactile sensory systems. Lastly, the literature review includes a short mention of usual interventions and explores past and current research for interventions targeting sensory subscales.

Figure 2-1 visually presents the structure of the literature review.

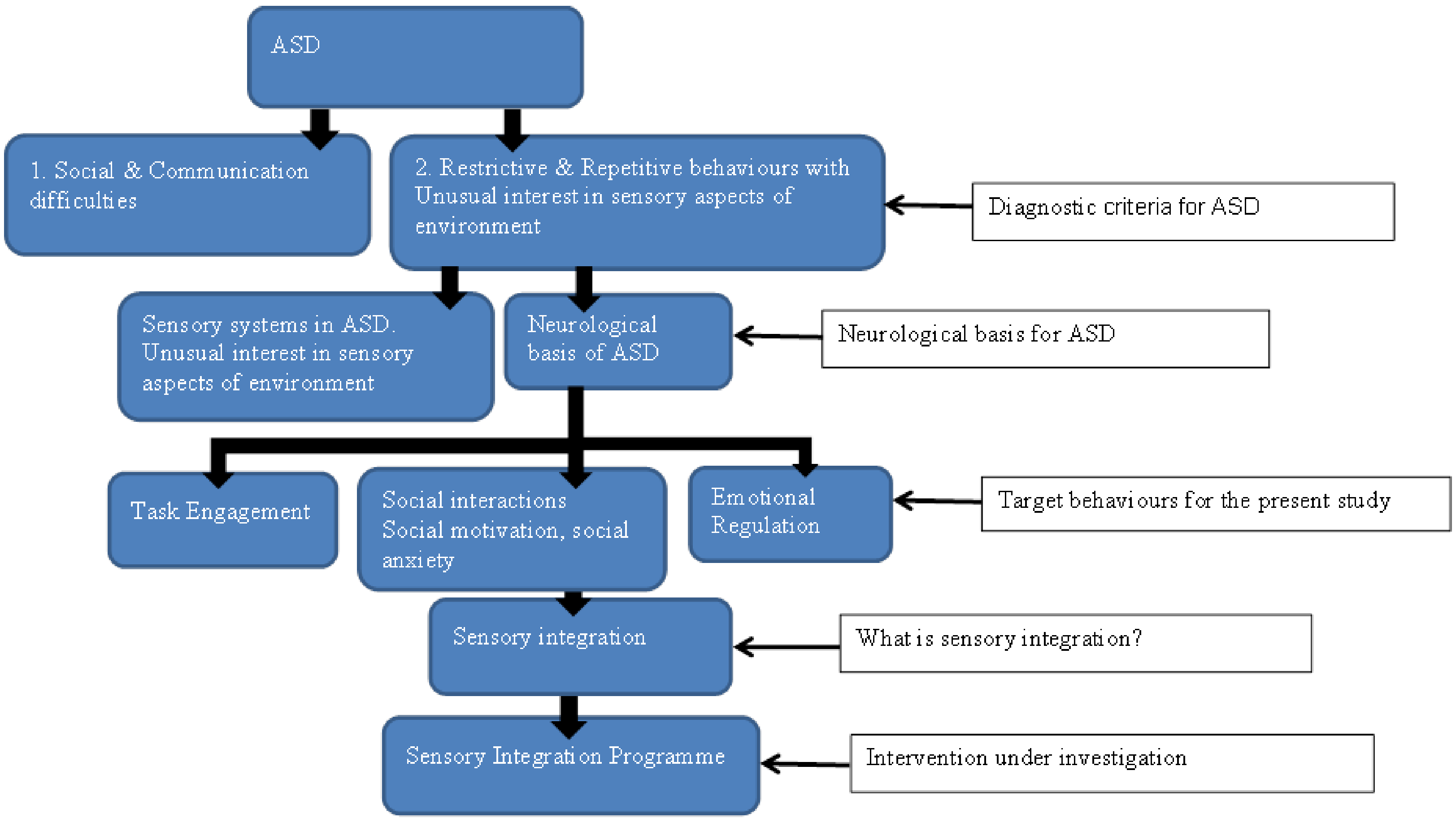


Figure 2-1. *Flow chart of the Literature Review*

Theories around autism

Four theoretical models have attempted to explain the core difficulties in autism: the Theory of Mind model (Baron-Cohen, 1990; Baron-Cohen, Ashwin, Ashwin, Tavassoli, & Chakrabarti, 2009; Baron-Cohen, Jolliffe, Mortimore, & Robertson, 1997), the Weak Central Coherence model (Frith, 1989), the Executive Function model (Hughes, Russell, & Robbins, 1994; Ozonoff, 1995; Prior & Hoffmann, 1990; Russell, 1997), and the Mirror Neuron System model (Rizzolatti, Fadiga, Gallese, & Fogassi, 1996). This last model was later qualified by the Social Top-Down Response Modulation (STORM) model (Southgate & Hamilton, 2008; Wang & Hamilton, 2012). These models are described in the following paragraphs.

The DSM-5 described a deficit in social and communication interactions as one of the criteria for diagnosing a child with autism (American Psychiatric Association, 2013). Premack and Woodruff (1978) introduced the term “Theory of Mind” to examine whether chimpanzees understood mental states. Developing this concept further, Baron-Cohen (1990, 1997) worked to try and explain the lack of awareness of the mental state of other people in individuals with autism. They introduced a model of Theory of Mind to explain this deficit (Baron-Cohen, 1990; Baron-Cohen et al., 1997; Baron-Cohen, Leslie, & Frith, 1985). By age four, a child typically develops the ability to look at another person, read his or her expression, and attribute it to that person’s state of mind at that moment (Baron-Cohen et al., 1985). In addition, the child is able to understand that another person’s state of mind is different from the child’s own state of mind. Children with autism appear to lack these abilities, or if they have them, fail to use them competently (if at all) in social interactions. This inability was termed “Mindblindness” (Baron-Cohen, 1997; Baron-Cohen et al., 1985). The Theory of Mind model attempted to explain the difficulties in socialisation, imagination, and communication experienced by individuals with autism. However, it did not adequately explain the other difficulties experienced by individuals with autism, and so neuroscientists, developmental psychologists, and other experts continued to study aspects of autism.

In an effort to understand the cognitive mechanisms at work in autism, researchers found that individuals with autism made continuous errors in strategic planning tests and failed to learn from their mistakes (Prior & Hoffmann, 1990). Children with autism also experienced difficulty transferring attention from one set of cues to another, which pointed to an involvement of the brain’s frontal lobes and a deficit in executive function skills (Hughes et al., 1994; Ozonoff, 1995; Russell, 1997). This deficit is the basis of the Executive Function theory (Ozonoff, 1995; Russell, 1997). Executive function of the frontal lobes of the brain includes forward planning, organisation skills, flexibility, memory and so forth. These difficulties (transferring attention and failing to learn from mistakes) appear to have a genetic link, as similar difficulties are often experienced to some degree by siblings and parents (Ozonoff, 1995). Children with autism appear to have difficulty in planning, starting or initiating a task, coming up with ideas for things to do, working in a flexible manner, and working from memory, and these difficulties impair their ability to begin, persevere, and complete a set task (Gilotty, Kenworthy, Sirian, Black, & Wagner, 2002; Happé, Booth, Charlton, & Hughes, 2006). Studies found a correlation between a deficit in executive function and absence of “Theory of Mind” (Ozonoff & McEvoy, 1994; Pellicano, 2007). The lack of cognitive skills included in executive function appear to have a developmental trajectory, do not always improve proportionately to age-related maturity, and in some cases may have a ceiling in development (Luna, Doll, Hegedus, Minshew, & Sweeney, 2007; Ozonoff & McEvoy, 1994; Pellicano, 2007). The cognitive skills included in executive function discussed above are essential to assess the requirements of a task, form a plan of action, and implement the plan using problem-solving skills when needed. Executive function from the frontal lobes and the connectivity from the corpus callosum enable all the afore-mentioned skills (Luna et al., 2007). When these skills are absent, the child tends to persevere at a task regardless of success or failure with it, and he or she may resist change and insist on rigidly maintaining the sameness in the environment and routines. Thus the Executive Function theory explains some of the repetitive behaviours and the obsessive need for sameness experienced by children with autism.

Children with autism have other abilities such as splinter skills (well defined skills, often in advance of age, but without apparent understanding or transferability), prodigious rote memory, restricted interests, savant skills in a specific area, and so forth. These abilities are not explained by the Theory of Mind, Mindblindness, and the Executive Function models, as these are mainly deficit models. A new model, Weak Central Coherence, was proposed to explain why some children with autism had an average or above average intelligence, yet failed to perform some context-specific tasks (Frith, 1989; Frith & Happé, 1994; Happé, Frith, & Briskman, 2001). The basis of Weak Central Coherence was that, in autistic children, there may be a problem in the processing of information and integrating it with other relevant information to derive a greater understanding, this being a higher-order cognitive process (Frith & Happé, 1994). Frith and Happé (1994) also found evidence of a genetic link, where parents and siblings of a child with autism may display some of the characteristics of the Theory of Mind, Executive Function, and Weak Central Coherence models (Happé et al., 2001).

A later explanation for specific savant skills was offered as a contrast to the Weak Central Coherence and Executive Function models. Baron-Cohen et al. (2009) argued that people with autism have an inherent ability to systemize tasks by their component parts, and this enabled some of these people to have an above-average success at complex tasks. This led to the Hyper-systemizing model (Baron-Cohen et al., 2009), which explained how hyper-sensitivity and hyper-attention (exclusive focus) on certain elements of a stimulus enabled some children with autism to systemise everything according to certain rules of structure and regularities. The Hyper-systemising model sought to explain that the hyper-sensitivity experienced by people and children with autism was a result of the range of neural connectivity within their sensory systems. In addition, this model provided an explanation for the narrow special interests, insistence on sameness (or resistance to change), and repetitive behaviours, characteristics that prevent children with autism from social integration and interactions (Baron-Cohen et al., 2009). The Hyper-systemising theory contrasted with the Executive Function theory because the latter assumed a lack of talent, whereas the Hyper-systemising theory assumed a specialised talent. The Weak Central Coherence theory assumed that an intense or localised focus is due to inability for global focus or is due to the inability to integrate the local into the global picture, whereas the Hyper-systemising theory explained these behaviours as the product of a highly purposeful specialised ability (Baron-Cohen et al., 2009).

The Mirror Neuron System (MNS) model was described as sets of different brain areas that became active when a person was: performing an action and when observing the action being performed by another person. The brain regions involved in the MNS were the inferior frontal gyrus (IFG) and the inferior parietal lobule (IPL), the somatosensory and the premotor cortex along with the anterior insula (Hamilton, 2013). The MNS model was first proposed by Rizzolatti et al. (1996), and has been explored in great detail using functional magnetic resonance imaging (*f*MRI), structural magnetic resonance imaging, magnetoencephalography (MEG), electroencephalogram (EEG), eye tracking and muscle activation (EMG), and behavioural studies. The afore-mentioned studies produced mixed findings, with participants displaying no response in the IFG, amygdala and premotor cortex when exposed to emotional stimuli (Dapretto et al., 2006; Grèzes, Wicker, Berthoz, & De Gelder, 2009), while displaying normal activation patterns within the IPL during goal-directed physical actions (Dapretto et al., 2006; Grèzes et al., 2009; Marsh & Hamilton, 2011).

The standard MNS model does not explain the social and communication difficulties in autism adequately and an alternate, the Social Top-Down Response Modulation (STORM) model, was proposed (Southgate & Hamilton, 2008; Wang & Hamilton, 2012). Initial studies of the STORM model appeared to exert top-down control on the mirroring of emotions and actions and suggested that weak top-down controls are found in individuals with autism. The weak top-down controls may lead to abnormal imitation and abnormal brain mirror responses peculiar to autism (Hamilton, 2013; Pellicano & Burr, 2012).

The cerebellum, corpus callosum and frontal lobes appear to be involved in all of the models described, with the temporal lobe also being implicated in the Mirror Neuron System and by further implication STORM, and Theory of Mind models (Schroeder, Desrocher, Bebko, & Cappadocia, 2010). The cerebellum is also connected to many cortical regions, and is responsible for motor functions, such as posture, balance, and movement, and higher-order cognitive functions, including executive function, social and, emotional processing (Allen & Courchesne, 2003; Brian, Tipper, Weaver, & Bryson, 2003; Corbett, Constantine, Hendren, Rocke, & Ozonoff, 2009; Fatemi et al., 2012). The prefrontal and temporal regions are involved in monitoring of social cognition, executive functions, and episodic memory (Corbett et al., 2009; Loveland, Bachevalier, Pearson, & Lane, 2008); while the mirror neuron system is considered responsible for understanding emotion in others through imitation of emotions, expressions and actions (Dapretto et al., 2006). Aside from all the different models involving various brain areas to explain the distinct functioning in autism, there are other possible explanations for it. There is evidence indicating involvement of immunological factors leading to cognitive dysfunctions (Han et al., 2011) and gene mutation among children with autism and their families (O’Roak et al., 2012). Genetic studies continue to look for linkages, associations, and causation between specific genes and characteristics of autism (Piggot, Shirinyan, Shemmassian, Vazirian, & Alarcón, 2009).

Sensory processing difficulties in students with autism

As previously noted, the current theories that seek to explain autism implicate different parts of the brain associated with sensory processing, so it was necessary to study the different sensory systems, understand sensory processing and its neurological basis, and explore the recommended intervention practices for autism. The original research by Ayres (1972) observed that children with autism had difficulty with registration of stimuli (signal detection and interpretation of the stimuli), modulation of the sensory input (inhibition of high intensity inputs or propagation of low intensity sensory inputs), interaction with the stimulus in the environment and/or the motivation to interact.

Research over the last four decades has suggested a relationship between Sensory Processing Disorder (SPD) and manifestation of the characteristics of autism (Baker et al., 2008; Chen et al., 2009; Lane et al., 2010). It is reported that 82% to 97% of children with autism have SPD to some degree, and this high prevalence of SPD is likely to contribute to restricted and repetitive behaviours (Ashburner et al., 2008; Gal et al., 2010). It has been suggested that SPD could be an indicator for developmental dysfunction in children with autism (Cheung & Siu, 2009; Kientz & Dunn, 1997).

Due to distinctive sensory processing, children struggle to make sense of their surroundings and have difficulties adapting their behaviour to the requirements of their surroundings (Ayres, 1980). The distinctive sensory processing impacts their ability to fully and successfully participate in activities (Reynolds, Bendixen, Lawrence, & Lane, 2011) and impacts their daily life in terms of disturbed sleep patterns and unusual sensory response to environment and stimuli (Lane, Reynolds, & Dumenci, 2012; Reynolds, Lane, & Thacker, 2012; Wigham, Rodgers, South, McConachie, & Freeston, 2015). These impacts may result in challenging behaviours such as anxiety, aggression, and injury to others or self, crying, withdrawal, and property damage, and these behaviours are often addressed through various behavioural and cognitive behaviour interventions (Heyvaert, Saenen, Campbell, Maes, & Onghena, 2014; Horner et al., 2002; Lewis & Sugai, 1999). Without interventions, the afore-mentioned challenging behaviours can create difficult situations in the classroom, as children with autism may be less able to meet basic social and educational requirements (Westwood, 2004), such as listening to instruction, looking at visual cues, and staying on task. Children are required to attend to classroom instruction, to engage with tasks without preoccupation with or ignoring some aspect of the task (or task material), and to refrain from aggressive and antisocial behaviours. Teachers, specifically special education teachers charged with teaching children with autism, therefore, need to know how to respond and adapt to the varied sensory needs of students in order for students to participate and progress in the classroom.

The relationship between sensory processing difficulties in children with autism and behaviours impacting classroom participation are well documented in the literature (Ashburner et al., 2008; Gal et al., 2010; Tomchek & Dunn, 2007). These sensory processing difficulties involve issues within vision, audition, olfactory, gustatory, and tactile subsystems and with the child's hypo- or hyper-sensitivity to the sensory stimuli within the environment (American Psychiatric Association, 2013). Deficits of processing of sensory information in autistic children at a neurological level have also been extensively investigated (Ahn, Miller, Milberger, & McIntosh, 2004; Ashburner et al., 2008; Baker et al., 2008; Ben-Sasson et al., 2009; Crane, Goddard, & Pring, 2009; Dunn et al., 2002; Kern et al., 2006; Lane et al., 2010; Marco, Hinkley, Hill, & Nagarajan, 2011a; Tomchek & Dunn, 2007). In addition to processing sensory information in an atypical manner, the autistic brain also has a distinct pattern of inhibiting attention to certain aspects of stimuli, as well as a selectivity when directing attention or joint attention (Brian et al., 2003; Lawson, 2013; Lepistö et al., 2006; McPartland, Webb, Keehn, & Dawson, 2011; Odriozola et al., 2016). Descriptions of the relationship between the different areas of the brain and their function in each of the aforementioned sensory subsystems are provided below in Figure 2-2. The same brain areas function differently in autism (Marco et al., 2011a; Spencer et al., 2006) as discussed in following subsections.

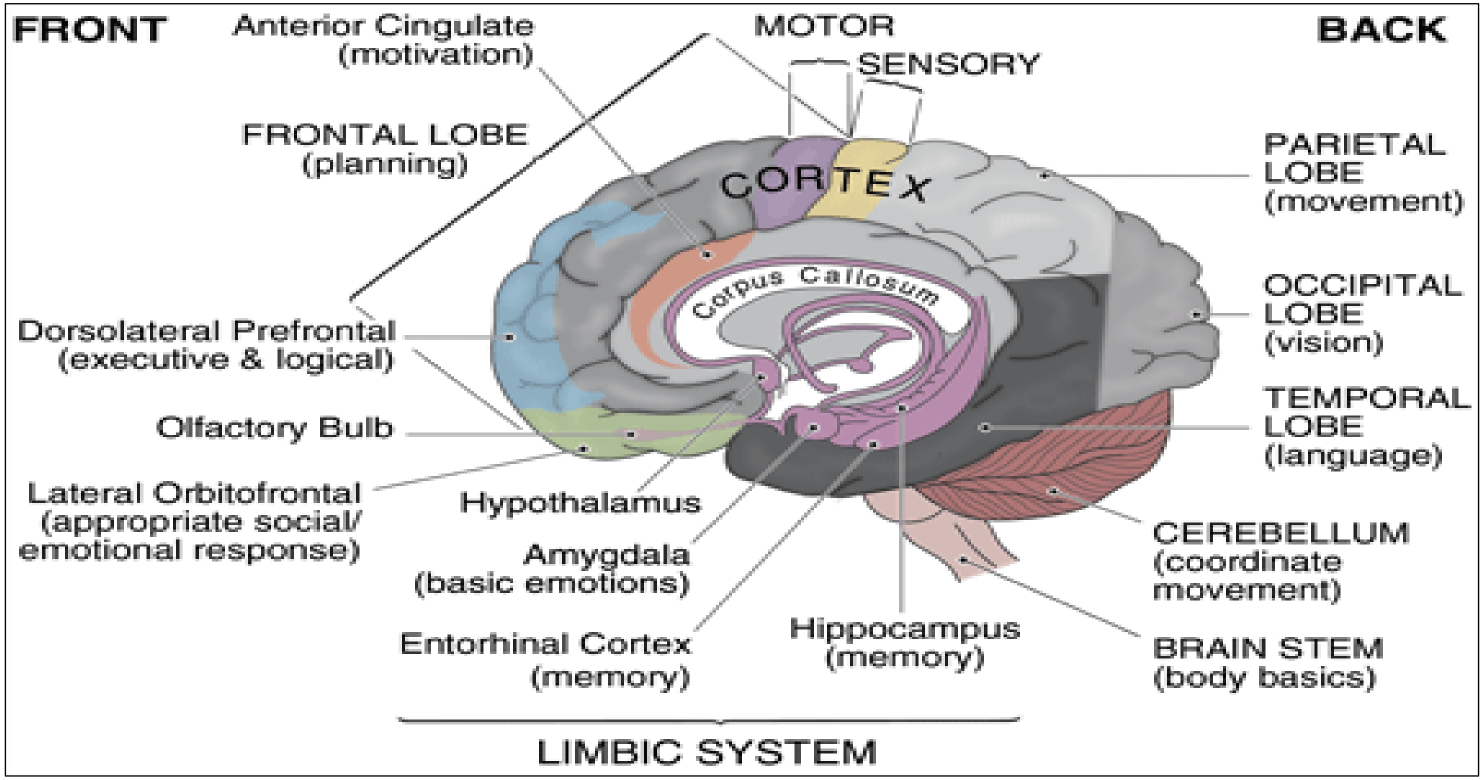


Figure 2-2. *Labelled diagram of the human brain* (Brainwaves, 2016)

Visual processing

Visual processing refers to controlling individual's movement in space and using information from the visual-spatial ability for cognition (Henderson, Pehoski, & Murray, 2002). Among children with autism, atypical visual processing behaviours have been observed across multiple research studies. Unusual behaviours were noticed among children with autism, including covering their eyes in the presence of bright lights and flicking their fingers in front of their eyes to seek extra stimulation (Leekam et al., 2007; Marco et al., 2011a). In other instances, it has been observed that children with autism focus on specific elements within a visual stimulus, thereby missing the "whole picture", as explained by the Weak Central Coherence theory (Bertone, Mottron, Jelenic, & Faubert, 2005; Dakin & Frith, 2005; Hyde, Samson, Evans, & Mottron, 2010; Mottron & Belleville, 1993; Perreault, Habak, Lepore, Mottron, & Bertone, 2015; Plaisted, Saksida, Alcántara, & Weisblatt, 2003). Also observed were challenges in detecting object boundary and contrast detection between still and moving objects, especially when defined by texture as compared to when defined by luminance (Jemel, Mimeault, Saint-Amour, Hosein, & Mottron, 2010; Sanz-Cervera, Pastor-Cerezuela, Fernández-Andrés, & Tárraga-Mínguez, 2015; Vandenbroucke, 2008). This visual property was initially attributed to Weak Central Coherence (Fletcher et al., 1995; Frith, 1989), where the brain failed to put together all the individual elements to form the "larger picture", but was later argued by Baron-Cohen et al. (2009) as a higher cognitive function (systemizing the visual stimulus according to the details). Such behaviours interfere with a child's classroom tasks by causing him or her to focus on the specific details of a task while others have moved on, or to miss the essence of the whole lesson in the confusion with all the insignificant details.

Children with autism face some recurring challenges in classroom engagement and social interaction to varying degrees due to atypical visual processing. These challenges varied from distinguishing faces against the background, paying or shifting attention to social factors such as one or more speakers, directing gaze towards someone or something, and fixation on the type of stimulus. Such difficulties interfered with classroom activities such as attending to teacher instruction, classroom discussions or participating in group projects (Vlamings, Jonkman, van Daalen, van der Gaag, & Kemner, 2010).

Children with autism who often failed to register that people have thoughts and feelings different from their own were more susceptible to missing social cues from the environment and people around them (Baron-Cohen, 1990; Baron-Cohen et al., 1997). This, in turn, affects the nature of their response in different situations. The Theory of Mind (or Mindblindness) was proposed to explain this social deficit amongst children with autism (Baron-Cohen et al., 2009). However, neurological studies indicated underlying atypical neural networks influencing sensory processing within the visual system, specifically, hyperactivity in the right amygdala and differential connectivity between frontal and temporal lobes. This different activation and connectivity is associated with atypical face processing (Vlamings et al., 2010), increased activation within local cortical regions (Rubenstein & Merzenich, 2003), challenged long-range connectivity between cortical regions (Belmonte et al., 2004), and an over-reliance on processing within the left primary cortex (Brieber et al., 2010). However, it was not clear whether this was due to disconnection within the neural networks of the limbic region which drives primary processing of sensory information (Marco et al., 2011a). These differences are hypothesized to be responsible for the visual-perceptual, social, emotional, and communication difficulties experienced by children with autism (Marco et al., 2011a; Rubenstein & Merzenich, 2003; Vlamings et al., 2010). The differences in connectivity and activation patterns discussed above manifest in behaviours such as occasional failure to take in the “whole picture”, focusing on particular parts of the whole, difficulty in noticing or interpreting the meaning of facial expressions, and so forth, plus difficulties in shifting attention and in verbal fluency. On the other hand, these neurological differences aid autistic children to display unusual ability in visual search tasks and excelling in detail-oriented tasks (Baron-Cohen et al., 2009). Understanding the different visual processing abilities in autistic children enable teachers to present learning tasks with visual supports, presenting a clutter-free environment, and augmenting verbal instruction with visuals.

Processing within the vestibular system

The vestibular system is the first to develop and becomes fully operational at 16 weeks of gestation. The vestibular mechanism contains two types of receptors, the first are the semicircular canals that detect the angular movement of the head and the second type are the otolith organs (utricle and saccule) that detect linear movement and pull of gravity (Lane et al., 2019). This system controls balance, sense of direction, and orientation for the foetus within the uterus (Goddard, 2002). The vestibular system and the auditory system are placed closely together in the middle ear and they control primitive reflexes that enabled a newborn to survive in the world outside the uterus (Goddard, 2002). The vestibular system matures as an infant grows and most of the infantile reflexes evolve into improved muscle tone, erect posture, a stable visual field, and balance, which are important for movements such as sitting, standing, and moving in space. It has been observed that many children with autism, as well as other developmental and neurological disabilities such as Down syndrome, Global Developmental Delay, and so forth, display a considerable amount of unresolved infantile reflexes, though a causal relationship between the two has not been established (Goddard, Swaab, Rombouts, & van Rijn, 2016; Goddard, 2002). However, since autism is a pervasive neurological developmental disorder (American Psychiatric Association, 2013), studying neurophysiology of the brain in autism could explain difficulties such as the struggle to sit in a classroom, to move confidently around school or classroom, and to manipulate writing tools or use other task materials efficiently, as well as difficulties with participation in various school activities, including sport (Kohen-Raz, Volkman, & Cohen, 1992; Ornitz, 1970). While early studies claimed neurological causes for observed postural differences and associated motor difficulties for children with autism, later studies refuted their findings (Ozonoff et al., 2008); although some neurological studies suggest motor difficulties, especially stereotypical movements, may be associated with autism (Loh et al., 2007; Mandelbaum et al., 2006).

Auditory processing

Auditory processing involves two basic functions: sound localization in the environment and lateralization between the two ears. It also involves auditory discrimination, auditory pattern recognition, and masking and filtering, resolution, integration, and ordering of audio signals (ASHA, 1996; Eyler, Pierce, & Courchesne, 2012; Kleinhans, Müller, Cohen, & Courchesne, 2008). Many children with autism have auditory processing difficulties (Bonnel et al., 2003; Lepistö et al., 2006; Plaisted et al., 2003), which give rise to difficulty in decoding auditory information (including speech and detailed instructions in the classroom), as the ability to comprehend different sounds, words, and sentences is necessary to understand language (Marco et al., 2011a). Studies by Eyler et al. (2012), Kleinhans et al. (2008), Knaus et al. (2010), and Nielsen et al. (2014) indicated that the auditory nerve, brain-stem, and associated auditory processing cortices were the brain areas implicated in auditory processing. These studies offered some explanation as to why children with autism may appear to not listen well, may not respond when called, miss important information discussed in class, or miss verbal cues for a task. While the classroom environment has high demands for processing and comprehension of speech and language, children with autism are neuro-physiologically and cognitively disadvantaged in meeting these requirements (Eyler et al., 2012; Kleinhans, Müller, et al., 2008; Knaus et al., 2010; Nielsen et al., 2014). Children with autism tend to have unusually high auditory filters that let in more background noise than in typical children (Plaisted et al., 2003) and can be very sensitive to certain speech or non-speech sounds based on their pitch (Bonnel et al., 2003; Mottron, Dawson, Soulières, Hubert, & Burack, 2006; O'Riordan & Passetti, 2006; Oram Cardy, Flagg, Roberts, & Roberts, 2005; Plaisted et al., 2003; Seery, Vogel-Farley, Tager-Flusberg, & Nelson, 2013). They also demonstrate natural orientation to non-speech sounds, such as environmental sounds with a certain pitch, compared to speech-sounds, such as typical vowel sounds (Lepistö et al., 2005; Lepistö et al., 2006; Whitehouse & Bishop, 2008). However, some children with autism are also known to process sounds in a highly systematic manner locally as well as globally, that is, they were able to correctly identify rising or falling group of notes (local processing) as well as rising and falling of the whole melody comprising of nine notes (global processing) (Bouvet, Simard-Meilleur, Paignon, Mottron, & Donnadieu, 2014).

Olfactory, gustatory, and tactile processing

Children with autism are often found to be fussy eaters due to their heightened sensitivity to taste and smell preferences, such as a liking for salty foods, avoiding foods with certain flavours or smells, or choosing sugary drinks over water (Cornish, 1998; Dominick, Davis, Lainhart, Tager-Flusberg, & Folstein, 2007; Field, Garland, & Williams, 2003; Klein & Nowak, 1999; Raiten & Massaro, 1986; Schmitt, Heiss, & Campbell, 2008; Schreck, Williams, & Smith, 2004; Whiteley, Rodgers, & Shattock, 2000; Williams, Gibbons, & Schreck, 2005; Williams, Dalrymple, & Neal, 2000). Children with autism tend to be sensitive to certain types of food textures, for example, choosing to eat only crunchy foods, discarding crusts from bread or pastry, refusing to touch or eat certain textures of food (Blakemore et al., 2006; Diolordi, del Balzo, Bernabei, Vitiello, & Donini, 2014; O'Riordan & Passetti, 2006). These behaviours and idiosyncratic food selections often lead to concerns around adequate nutrient intake and resulting health issues (Cermak, Curtin, & Bandini, 2010; Heiss, Moody, Crosley, & Campbell, 2005; Lane, Geraghty, Young, & Rostorfer, 2014; Sharp et al., 2013). Recent research indicated that meal time behaviours of children with autism, resulting from sensory sensitivities could be improved through application of sensory strategies, such as play-based activities as suggested by occupational therapists (Lo et al., 2007; Zobel-Lachiusa, Andrianopoulos, Mailloux, & Cermak, 2015).

Neurological basis for this study: autism and its relationship to sensory processing

From the afore-mentioned studies of different neural networks within sensory systems, how they work, and the impact of the neural networks on the processing of sensory information it was clear that the autistic brain behaved in a distinctly different manner to a typically developing brain (Bauman & Kemper, 2005; McAlonan et al., 2004; Vargas, Nascimbene, Krishnan, Zimmerman, & Pardo, 2005). Unique patterns in the processing of information in individuals with autism influenced behaviours of those individuals, for example, as obsessions or repetitive behaviours, and give rise to specific strengths, such as sorting visual information and developing specialised interests. This unique processing was also hypothesized to be responsible for social, emotional, and communication difficulties. It was therefore important to discuss the autistic brain in terms of its physical characteristics, such as size and volume, activation patterns, and connectivity within and between different areas of the brain, to understand the impact of autism on individual learning abilities and behaviours.

Physical characteristics

While new research looks for probable aetiology contributing to autism, such as genetic variation, environmental exposure, and prematurity (Lai et al., 2013; Marco et al., 2011a), several studies have found an enlarged head circumference between the ages of 1 and 2 years as a consistent finding (Chawarska et al., 2011; Courchesne, Campbell, & Solso, 2011; Courchesne, Lincoln, Kilman, & Galambos, 1985; Courchesne, Lincoln, Yeung-Courchesne, Elmasian, & Grillon, 1989; Hazlett, Poe, Gerig, & et al., 2005; Hazlett, Poe, Gerig, & et al., 2011). The physical structure of an autistic brain is thus distinctive with enlarged total brain volume, which extended to the grey and white matter of frontal, temporal, and parietal lobes, and extended to sub-cortical structures, such as the amygdala and the caudate nucleus (Chawarska et al., 2011; Lenroot & Giedd, 2006). While there was no obvious difference in cortical thickness, there was a significant increase in surface area within the temporal, frontal, and occipito-parietal regions (Hazlett et al., 2005; Hazlett et al., 2011). Studies have shown children with autism have increased cortical thickness in the neocortex and cerebellum (McKavanagh, Buckley, & Chance, 2015), and temporal and parietal lobes (Hardan, Keshavan, Sreedhar, Vemulapalli, & Minshew, 2006). Conversely, cortical thinning was observed in the temporal and parietal lobes among adolescents and adults with autism (Hadjikhani, Joseph, Snyder, & Tager-Flusberg, 2007; Wallace, Dankner, Kenworthy, Giedd, & Martin, 2010). Further studies indicated that this enlargement in children with autism was due to an “abnormally excessive” number of neurons, especially in the prefrontal cortex (Courchesne et al., 2011). It is believed that the differentiated columnar widths of axonal bundles within primary as well as secondary sensory cortices is the cause of unique discrimination to be found and appears to continue in adults with autism (McKavanagh et al., 2015). The above mentioned physical characteristics of brain development are implicated in the atypical developmental trajectory observed among autistic children. The differing cortical thickness and difference in proportion of gray and white matter influence activation patterns in brain regions when exposed to sensory stimuli. This, in turn, may be responsible for how children with autism interacted with the environment and their learning behaviours through a different sensory lens than their neurotypical counterparts (Bauman & Kemper, 2005; McAlonan et al., 2004; Vargas et al., 2005).

Activation patterns and connectivity

While past studies involved post-mortem analysis of autistic brain tissue, magnetic resonance imaging (MRI) techniques have helped to study the living brain, leading to a better understanding of activation patterns and neuronal connectivity, both local and global (Wass, 2011), and especially of abnormal connectivity in the right and left frontal lobes and the corpus callosum (Catani et al., 2016).

Studies revealed reduced functional connectivity within the amygdala, visual cortex and prefrontal cortex, which has a negative effect on appropriate emotion processing from facial expressions (Cheng, Rolls, Gu, Zhang, & Feng, 2015). This type of differentiated connectivity impacts sensory, perceptual, attentional, emotional, and cognitive processing (Cody, Pelphrey, & Piven, 2002; Dalton et al., 2005; Hazlett et al., 2012), confirming earlier observations of Weak Central Coherence and atypical neural processing of visual and auditory information (Bonnel et al., 2003; Bouvet et al., 2014; Lepistö et al., 2005; Plaisted et al., 2003). Further, decreased activation within the parietal gyrus and increased activation in the planum temporale indicated that children with autism relied on visual strategies when presented with language processing tasks (Pierce, 2011; Rudie et al., 2012; Stigler, McDonald, Anand, Saykin, & McDougle, 2011). Similar unusual activation in visual cortex and frontal lobes, affecting word processing, was observed in adults with autism as well (Barbeau et al., 2015; Gaffrey et al., 2007). This type of processing indicates that children with autism relied on visual imagery to understand words and sentences. Such studies confirm the effect of structural brain differences, and the communication impairment component of the diagnostic criteria for autism (American Psychiatric Association, 2013).

Brain-behaviour links in autism spectrum

Studies from developmental cognitive neuroscience indicated that distinct patterns of processing within the temporal lobes influenced attention towards social stimuli (McPartland, Webb, et al., 2011; McPartland, Wu, et al., 2011), abnormalities in the fusiform gyrus and frontal lobes contributed to a lack of empathy (Greimel et al., 2010; Hadjikhani et al., 2007), and abnormal activation in the fronto-parietal lobes caused memory dysfunction in social contexts (Greimel et al., 2012; Wass, 2011). Within the autistic brain, unusual connectivity and activation was observed within the temporal lobes, fusiform gyrus, prefrontal cortex, and amygdala, along with differences in the dopamine and oxytocin levels; and the combination of these had an effect on the reward mechanism of social interactions (Corbett et al., 2014; Kleinhans, Richards, et al., 2008; Lombardo et al., 2010; Neuhaus, Beauchaine, & Bernier, 2010). It has also been noted that the autistic brain has very atypical activation and inhibitory responses to stimuli, and that these responses are influenced by the nature of each stimulus (Snijders, Milivojevic, & Kemner, 2013). The unusual processing of social stimuli within the autistic brain also has implications for memory dysfunction (Williams, Goldstein, & Minshew, 2005) and intellectual development (Vivanti, Barbaro, Hudry, Dissanayake, & Prior, 2013). These findings supported the Theory of Mind model (Baron-Cohen, Leslie, & Frith, 1985), the Weak Central Coherence model (Frith, 1989), and the Mirror Neuron System model (Rizzolatti et al., 1996), as well as the diagnostic criteria of social and emotional difficulties associated with autism spectrum as mentioned in DSM-5 (American Psychiatric Association, 2013).

Restricted and repetitive behaviours and heightened sensory response to insignificant stimuli are typically associated with autism (American Psychiatric

Association, 2013). Focused attention, shifting of attention, and selective attention are affected in the particular style of cognitive processing in autism (Marco et al., 2011a). The autistic brain shows distinct patterns of selective attention and decreased modulation within the occipital and parietal networks. This led to individuals being vulnerable to noise and cross-talk, interfering with attention to the task at hand (Belmonte & Yurgelun-Todd, 2003).

Studies investigating selective attention demonstrated that children with autism were able to block distractors when presented with visual supports to complete their tasks; while addition of a colour feature within the task helped to improve task performance of autistic children as compared to controls (Brian et al., 2003). Such selective visual processing has been reported previously in the literature (Courchesne et al., 1985; O'Riordan & Passetti, 2006; Plaisted et al., 2003). This information indicates the challenges faced by students with autism in a typical classroom with a high reliance on classroom discussions, group projects, and verbal instruction, but does offer potential for addressing these by using extra visuals or colour to supplement verbal instruction.

Neurology of behaviours in children with autism

Neurology for task engagement in autism

Task engagement in children with autism involved the premotor and parietal cortex, the dorsal striatum, and the cerebellum, with the dorsal striatum known to control movements and different types of learning (Ciesielski, Lesnik, Savoy, Grant, & Ahlfors, 2006). Furthermore, task engagement was facilitated with the engagement of the visual dorsal and sensory-motor pathways, and used cognitive and visual-spatial strategies when the task was augmented by action and animation (Ciesielski et al., 2006; Minshew & Keller, 2010). The premotor and parietal networks along with sensory-motor pathways were functional for task engagement within early childhood, when the child learns through repeated movements. The autistic brain that relies on early developmental neural networks and had higher cerebellar activity, with increased activity in the visual and auditory systems, needed highly efficient sensory integration to engage and learn (Ciesielski et al., 2006; Danzl, Etter, Andreatta, & Kitzman, 2012). Furthermore, task engagement may be encouraged when children can manage registration and modulation of sensory stimuli from the task material (Kilroy, Aziz-Zadeh, & Cermak, 2019). Other literature indicated that, in the case of children with autism, there was unusual activation within the visual, pre-frontal, and parietal cortex (Courchesne et al., 1985; Greimel et al., 2012; O'Riordan & Passetti, 2006; Plaisted et al., 2003), and this suggested that task engagement may be challenging for children with autism. Task engagement involves the neural networks of three systems: the recognition system that receives sensory inputs and recognises their patterns, the strategic system to plan and execute the action, and the affective system that relies on individual preferences (Pisha & Coyne, 2001). Challenging and engaging these neural networks enables task engagement: this is achieved through a combination of active participation, meaningful activities, and deliberate application of effort seen through the action of starting and continuing a task (Danzl et al., 2012). These features of engagement could be well supported by using a classroom-based programme that aimed to integrate all senses.

Neurology for social motivation in autism

Functional magnetic resonance imaging (*f*MRI) scans have shown the neural architecture of social behaviours that include the superior temporal cortex, amygdala, orbitofrontal cortex, insular cortex, and medial frontal cortex (Barrasso-Catanzaro & Eslinger, 2016; Goddard et al., 2016). The brain responds to a social stimulus, which can be seen as changes in the amygdala and some regions in the prefrontal and temporal cortices, and a change in the level of hormones, such as oxytocin (Kanat, Heinrichs, & Domes, 2014). Regions in the dorsal and ventral anterior insula have distinct activation patterns and connectivity in response to stimuli from social events if those events are perceived as “meaningful” by individuals (Odriozola et al., 2016). It was therefore evident that social behaviour and response to social stimuli are highly complex processes guided by distinct neurology.

One of the criteria for autism according to DSM-5 (American Psychiatric Association, 2013) is social and communication impairment (American Psychiatric Association, 2013). Typically, people make functional use of language to regulate themselves socially during social interactions. Social interactions among neuro-typical individuals and groups are governed by psychological inclinations (social motivation) and biological mechanisms that direct them towards social interactions (social orienting), to seek pleasure from social interaction (reward mechanism) and then work towards maintaining the social contact (social maintaining) (Chevallier, Kohls, Troiani, Brodkin, & Schultz, 2012). Children with autism find the ability to make functional use of language in social situations difficult to varying degrees (Joseph, McGrath, & Tager-Flusberg, 2005; Loucas et al., 2008). It is believed that social difficulties in children with autism may be impacted by lack of social motivation and social cognition (i.e., understanding the social concept of language and social information). Social motivation and social cognition are considered to be evolutionary concepts for neuro-typical people and cause individuals to seek social interactions, find them rewarding, and promote maintaining of effective social bonds (Bernhardt et al., 2014), and these, in turn, foster relationships, cooperation, and collaboration (Chevallier et al., 2012). In addition, social motivation may be influenced by registering of the social stimulus such eye contact, whether the child finds any reward from having eye contact and then be motivated to continue with the social engagement (Kilroy et al., 2019). The paucity of social motivation among children with autism may be explained by Mindblindness (Baron-Cohen, 1990) or by atypical visual processing (Harms, Martin, & Wallace, 2010; Hellendoorn et al., 2014; Irwin, Tornatore, Brancazio, & Whalen, 2011; Wiggins, Kurapati, Carrasco, & Maslowsky, 2010), both of which lead to lack of interest in pursuing, initiating, and maintaining both social interactions and experiences, in turn leading to difficulties in social cognition. In recent times, research has investigated the reward mechanism that may drive motivation, by looking for activation patterns and effects of oxytocin and dopamine on social decision-making (Odriozola et al., 2016; Ruff & Fehr, 2014), as levels of these neurotransmitters were found to be different in children with autism.

There are activation deficits in the bilateral middle temporal gyrus and post-central gyrus during tasks that involve attributing mental states; similar activation deficits were observed in the right nucleus accumbens during activities when the participants were motivated by intrinsic or extrinsic rewards (Assaf et al., 2013; Hadjikhani et al., 2004; Hadjikhani et al., 2007). Connectivity within neural structures in the parieto-occipital tracts is thought to have an effect on multisensory integration.

Connectivity within the temporal region, such as the fusiform-amygdala and fusiform-hippocampus, was thought to impact socio-emotional processing and involved auditory processing, visual memory, social skills and inattention (Carré et al., 2015; Chang et al., 2014) as seen in Figure 2-3. The distinct connectivity and activation in the above mentioned brain areas of autistic children are involved in processing of social stimulus. The impact of this different connectivity and activation on observed behaviours are discussed in detail as follows (Hoyson, Jamieson, & Strain, 1984).

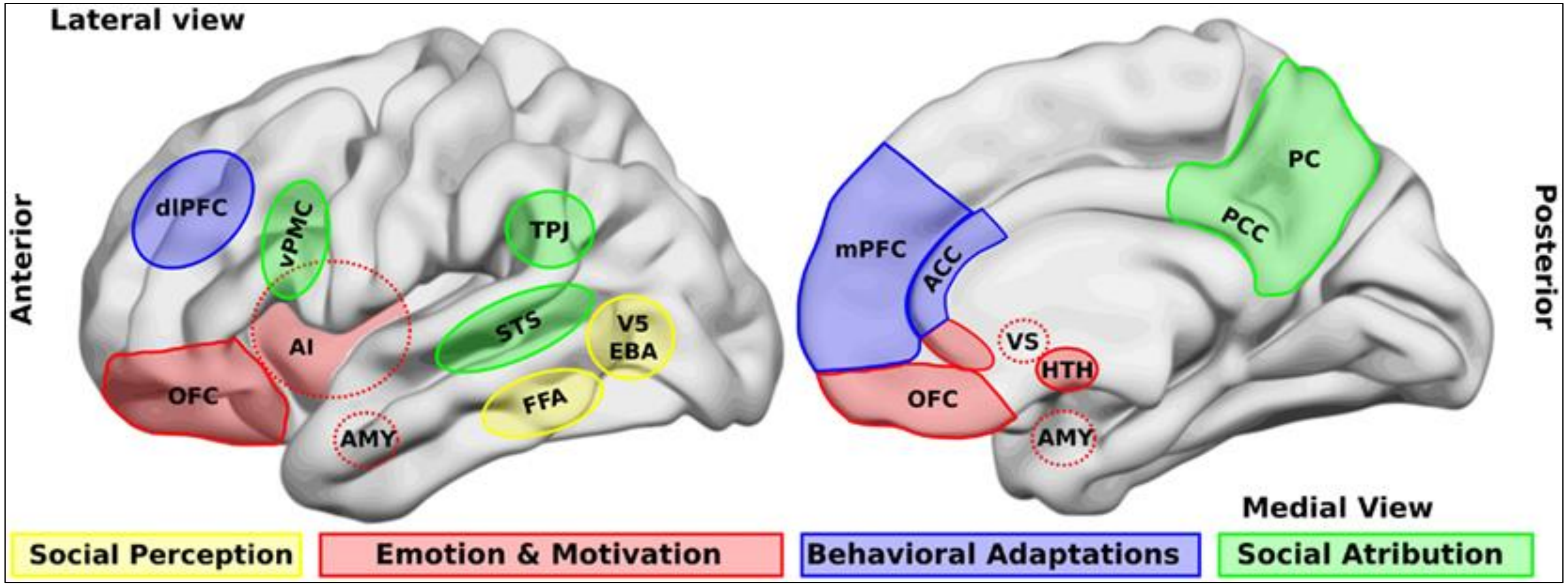


Figure 2-3. *Brain areas that participate in social processing* (Billeke & Aboitiz, 2013)

In Figure 2-3, EBA is extrastriate body area (parts of body), FFA fusiform face area (faces), AMY amygdala, AI anterior insulate, ACC subgenual and perigenual anterior cingulate cortex, OFC orbitofrontal cortex, VS ventral striatum (biological motions), HTH hypothalamus, dlPFC dorsolateral prefrontal cortex, mPFC medial prefrontal cortex, vPMC ventral premotor cortex, STS superior temporal sulcus, PCC posterior cingulate cortex, and PC precuneous.

The brain areas depicted in Figure 2-3 illustrate the regions with different activation patterns and connectivity as explained earlier and coincide with social behaviours unique to children with autism, as discussed henceforth. Behavioural studies such as by Kim et al. (2015) have indicated that children with autism display atypical social motivation and reduced sensitivity to reward within social situations. In these studies, children with autism were also more involved in self-play and were less motivated to interact with others (Corbett et al., 2014). A study investigating social motivation reported that, while children with autism did not automatically choose pictures with an expression of happier emotions, they also did not move away from scenarios with negative emotions, indicating that children with autism do not appear to be motivated by the emotional impact of a situation or of social stimuli (Kim et al.; 2015). Chen, Bundy, Cordier, Chien, and Einfeld (2015) report that diminished social motivation is associated with a higher level of social anxiety, and that social anxiety, in turn, leads to negative emotions (such as fear and anxiety about social situations), resulting in controlling behaviour, such as resisting change and rigid routines (Factor, Condy, Farley, & Scarpa, 2016). Children with a higher level of social anxiety appear to perceive social situations as difficult to face (Chen et al., 2015) and this leads to further social motivation deficits (Factor, Condy et al, 2016). While social motivation influenced task performance for most individuals, the performance of children with autism is not affected by the level of motivation (Geurts, Luman, & Van Meel, 2008); although autistic children were aware of being different, which caused them to make fewer attempts at initiating social interactions (Chen et al., 2015). The absence of social motivation affects the way adolescents with autism represent themselves to others, with only a marginal increase in social interaction when they were offered a reward or incentive (Scheeren, Banerjee, Koot, & Begeer, 2016).

In summary, social interactions are found to depend on the level and intensity of social motivation and whether or not the individual found the interaction rewarding. Social interactions are influenced by fear and anxiety, and the feeling of being “different”. This explained the varied social behaviours of children with autism: controlling behaviours, shutting out other people, appearing to ignore social conventions, talking over other people, and so forth.

Neurology for emotional regulation in autism

Emotion is described as a positive or negative response to external stimuli and is an internal experience that causes behavioural and environmental changes (Ochsner & Gross, 2005). Emotional regulation is defined as the different strategies employed to recover from an emotional experience, such as, amplifying, maintaining, altering, and managing (Gyurak, Gross, & Etkin, 2011; Ochsner & Gross, 2005; Roberts, Clarkson, Cummings, & Ragsdale, 2017; Tárrega et al., 2014). The neural networks implicated in emotional regulation are different regions within the prefrontal cortex and subcortical regions, as well as the amygdala, insula, hypothalamus, hippocampus, parahippocampal gyrus, fornix, mammillary body, septal nuclei, cingulate gyrus and the dentate gyrus on both sides of the thalamus (Kilroy et al., 2019; Phillips, Ladouceur, & Drevets, 2008; Richey et al., 2015). Emotional regulation is initiated by the prefrontal and dorsolateral cortices, while the ventrolateral prefrontal cortex signals the significance and need to modulate a response (Kohn et al., 2014). In autism, dynamic changes are found in the amygdala and prefrontal cortex (Diano et al., 2017; Mazefsky et al., 2013), thus indicating a significant influence on the process of emotional regulation. Other brain areas, such as the insula, are also thought to be connected to anticipation of negative experiences and the effect of this anticipation on heightened level of anxiety (Mazefsky et al., 2013). It has been observed that there was a neutral response to pleasant textural inputs and an extraordinarily strong response to unpleasant texture inputs in the somato-sensory areas of the brain including the posterior cingulate cortex and the insula (Kilroy et al., 2019). The socio-cognitive process of emotional regulation starts with a successful review of the stressor, resulting in lowered anxiety and an increase in positive emotion. This change is reflected by activation in the medial and prefrontal cortical regions along with decreased connectivity between the amygdala and the prefrontal and visual cortices (Uchida et al., 2015). While most children learn emotional regulation by observing adults and peers, and socio-cognitive coaching, children with autism and intellectual disability are known to struggle with recognising emotion in themselves and others, and to struggle with naming emotions, and these struggles make it difficult for them to regulate their emotions (Mazefsky et al., 2013; White et al., 2014).

It has been observed that anxiety and fear co-exist and impair emotional regulation for individuals with autism (Marin & Milad, 2016; White et al., 2014). The typical behaviours observed are rumination on events, remaining focused on the stressors, and either emotional arousal or shutting down (Mazefsky, Borue, Day, & Minshew, 2014). Children with autism experienced more emotional disruptions, less amusement, and used fewer strategies for emotional regulation compared to their neuro-typical counter-parts (Samson, Hardan, Lee, Phillips, & Gross, 2015; Samson, Hardan, Podell, Phillips, & Gross, 2015; Samson et al., 2014; Samson, Wells, Phillips, Hardan, & Gross, 2015). It is considered that reduction or lack of emotional regulation is closely related to all of the core features of autism and social anxiety, as well as having a strong association with restrictive and repetitive behaviours (Samson et al., 2014; Swain, Scarpa, White, & Laugeson, 2015). In summary, current research into neurology of autistic brain connectivity and activation patterns support the earlier hypotheses made by A. Jean Ayres in her sensory integration theory: difficulties experienced by autistic children to formulate an adaptive behavioural response are due to difficulties experienced in sensory registration, sensory modulation and /or motivation (Kilroy et al., 2019; Lane et al., 2019).

Neurology of intellectual disability in autism

Genomic research into the comorbidity of intellectual disability and autism has identified some chromosomal mutations caused by deletion and duplication (Berryer et al., 2013; Mefford , Batshaw , & Hoffman 2012; Srivastava & Schwartz, 2014). Smith and Matson (2010); Tallantyre and Robertson (2013) identified that individuals having dual diagnosis of intellectual disability and autism had behaviour problems, with higher the number of mutations, higher the severity. These genetic studies have helped scientists to track molecular pathways affecting neural synaptic dysfunctions in the neural networks of the brains of people with both intellectual disability and autism (Berryer et al., 2013; Zoghbi & Bear, 2012). Structural differences observed in the brains of people with dual diagnoses are reduced grey matter density in the thalamus and increased white matter density in the left superior temporal gyrus (Spencer et al., 2006). These areas have previously been seen (see Neurology for auditory processing and for emotional regulation in autism) to be involved in language processing, auditory processing, and processing of emotions. There is, however, a paucity of research into how the structural and functional neurological networks correlate and connect in the brains of individuals with dual diagnosis of autism and intellectual disability.

These neurological insights into brain-behaviour relationships of people with autism and intellectual disability indicate that automatic processing of sensory information is challenged and that children experienced sensory overload and anxiety which may lead to behavioural difficulties. The unique neural activation and connectivity within different brain areas appear to have an effect on motivation by affecting reward mechanisms and impact cognitive processing, as well as sensory processing. Ashburner et al. (2008) reported high incidence of differentiated sensory processing causing hyper- or hypo-reactivity to the sensory nature of stimuli within the environment, which is one of the diagnostic criteria for autism according to the DSM-5 (American Psychiatric Association, 2013). As evident from literature examined, specific neural networks are impacting observable behaviours such as task engagement, social interaction and emotional behaviours. It would be prudent then, to examine what interventions may be available to support the children with autism and intellectual disability to formulate adaptive responses to the sensory stimuli in their environments such as a classroom environment.

Thus, sensory processing in autism needs to be studied further as it can often have significant impact on classroom behaviours for students with autism.

Intervention Strategies

Existing interventions and intervention strategies

Most known interventions have addressed social, communication, and behavioural challenges faced by children with autism. There are 27 interventions identified as Evidence-Based Practices (EBPs) (Odom, Collet-Klingenberg, Rogers, & Hatton, 2010; Wong et al., 2015), such as antecedent based intervention and cognitive behavioural intervention. The National Professional Development Centre on Autism Spectrum Disorders (NPDC) published a report identifying evidence-based interventions that had been clearly developed to facilitate replication of desired effect, had a sufficient number of independent studies to support their efficacy, and had a large number of participants (Wong et al., 2015). The report acknowledged 30 Comprehensive Training Models (CTMs), such as the TEACCH programme developed by Schopler, Brehm, Kinsbourne, and Reichler (1971), The Early Start Denver Model developed by Smith, Rogers, and Dawson (2008), the Young Autism Programme developed by Lovaas (1987) and the LEAP programme developed by Hoyson et al. (1984).

The NPDC report also identified 27 focused intervention strategies that targeted specific learning goals for the individual which might be a behavioural, developmental or an academic goal, and facilitated replication through a clear documented process and was conducted over a definite period of time shorter than the time involved in CTMs. Some of these focused interventions were discrete trial teaching, pivotal response training, prompting, video-modelling, and so on (Odom et al., 2010; Wong et al., 2015). EBPs are delivered in a home setting, community setting, or clinical setting. Of the 27 EBPs, only Exercise, used increased physical activity to increase desirable behaviours such as time on task, correct responding, and decrease in undesirable behaviours, such as aggressive behaviours or self-injury; other EBPs were systematically instruction-based intervention procedures. Researchers found that when exercise was used as an antecedent to academic activities, task engagement and correct responding increased proportionate to the amount of time spent exercising for students (Nicholson, Kehle, Bray, & Heest, 2011; Oriel, George, Peckus, & Semon, 2011). Several other studies used swimming, aqua-exercises, horse riding, and kata techniques (to be found in martial arts) as antecedent procedures and found similar results (Bahrami, Movahedi, Marandi, & Abedi, 2012; Celiberti, Bobo, Kelly, Harris, & Handleman, 1997; Gabriels et al., 2012; Kern, Koegel, & Dunlap, 1984). One study compared walking versus jogging as an antecedent intervention strategy and found positive results for jogging but not for walking (Celiberti et al., 1997). It may be useful to identify the specific type of sensory feedback offered by these forms of exercise, since the classic form of sensory integration is based on proprioceptive, tactile and vestibular feedback (Ayres, 1972).

Many other antecedent and consequence-based EBPs address the challenges of sensory difficulties by mitigating the sensory stimuli in the environment, such as, taking regular breaks during a classroom task, withdrawing to a quiet space to avoid sensory overload caused by classroom noise, and using noise-cancelling headphones for the same purpose. Similarly, sensory seeking students can be offered sensory activities at regular intervals to maintain their level of alertness (Wilbarger & Wilbarger, 2002). Such interventions, while addressing sensory difficulties, are based on modifying the environment.

While the EBPs included exercise, the NPDC report excluded sensory diet and sensory integration as an EBP due to having insufficient evidence to support inclusion as an EBP. At the same time, sensory integration and sensory-motor programmes are the only interventions aimed towards directly addressing sensory difficulties experienced by children with autism by claiming to effect a change in the modulation or processing within the nervous system (Ayres, 1972, 1976, 1978, 1980; Ayres & Tickle, 1980). The sensory integration intervention based on Ayres' principles of sensory integration (stimulus enriched environment, child-initiated activities and tailored for the individual play based activities) is a more direct intervention based on the principle of neuroplasticity compared to other behaviour based or cognition based EBPs that also focus on bringing about change in the adaptive response, but through the antecedent and consequence based models (Kilroy et al., 2019; Lane et al., 2019). Given these facts, it was important to study the effectiveness of interventions that target sensory processing.

Interventions targeting engagement and challenging behaviours

Traditionally, sensory integration intervention was provided by an occupational therapist (OT) in a clinical one-on-one setting. This practice followed an established delivery model of evaluation, goal setting, intervention, and re-evaluation (Fisher & Jones, 2009), and was based on the principle that task demands and environment demands combined with "person factors" and "body functions", produce occupational outcomes such as motor skills, social interactions, and so forth. The "person factors" referred to a person's values, beliefs, habits and roles, and the "body functions" referred to memory, cognitive and perceptual skills, motor planning, emotional regulation, fine motor coordination, speech, joint mobilisation, and pain management (Fisher & Jones, 2009, p. 249).

Trials of integrating occupational therapy in a school setting produced improvement in fine motor skills, visual motor skills, hearing, and sound identification among students with and without disability (Bazyk et al., 2009; Case-Smith, 2002). These studies also identified the need for a collaborative model of intervention that included parents and school staff in the goal setting and intervention process (Bazyk et al., 2009; Case-Smith, 2002; Villeneuve & Shulha, 2012). Parents' perspectives suggested that there were barriers for parent participation in the assessment, goal setting, intervention, and re-evaluation process (Tucker & Schwartz, 2013), while teacher perspectives indicated that a lack of clear understanding of roles and responsibilities, along with insufficient teacher training, interfered with effective collaboration among the key participants (Koegel, Matos-Freden, Lang, & Koegel, 2012; Villeneuve & Shulha, 2012).

There is therefore a consensus promoting collaborative practice among educators, families, and intervention specialists such as OTs. Examples of collaborative programmes are the Partnering For Change (P4C) initiative (Campbell, Missiuna, Rivard, & Pollock, 2012; Missiuna et al., 2012; Sayers, 2008; Villeneuve & Shulha, 2012) and the Occupational Therapy in Schools (OTiS) programme (Hutton, 2009). The role of therapists in these models was to help teachers recognise and identify motor issues with the children, make necessary environmental adjustments, and tailor instructional strategies that would help individuals or groups of students. Onsite presence of therapists meant that teachers were supported with flexible strategies for incidental issues that cropped up frequently in the classroom (Campbell et al., 2012; Koegel et al., 2012; Missiuna et al., 2012; Villeneuve & Shulha, 2012).

The P4C model of intervention involved seven community based OTs who were trained extensively in the model delivery and received ongoing coaching support from their trainers through the school year. Their role was to assist teachers to identify at-risk students, help make adaptive changes to the classroom environment and equipment, help the teachers to develop instructional strategies, and model the delivery of those strategies to individual, small groups of, or the whole group of students as was deemed necessary. The emphasis of the model was on therapist perspectives, and the key outcomes of the model were reported to be a feeling of increasing confidence by the continued partnership with the therapist community, a sense of wellbeing through building strong collaborative relationships with the school staff, and the successful partnerships built between the children, therapists and the teaching staff (Campbell et al., 2012; Missiuna et al., 2012).

The OTiS programme implementation included the OTs offering a motor coordination programme alongside teachers and paraprofessionals. The two therapists were allocated to two schools and visited the schools twice a week over two school terms. The goals at the participant schools were: increasing student participation and engagement, and included colouring, cutting, writing, using cutlery for eating, and physical activities. The therapists also delivered a motor coordination programme alongside the teachers and paraprofessionals. The programme outcomes recorded from staff interviews identified an increased level of knowledge, skills and confidence, and a collaborative sense of team spirit (Hutton, 2009).

In both the programmes described above, it was observed that, when compared with the pull-out model (where the therapist worked with the students away from the classroom), teachers were more likely to continue the programme as a result of their increased confidence, and a wider student population could receive the therapeutic intervention. However, it was found that the OTiS programme was at risk of stagnation after the therapist was withdrawn, along with subsequent loss of interest by students and teachers. One more example of collaboration between a private service provider and educators was (OT for Kids) in the UK, which offered teacher training and continued support with consultation; educators from at least four schools, namely, Crumpsall Lane Primary School, Trinity High School, St Georges Primary School, and so forth have participated in the programme. The positive response from the participating staff and outcomes for children led to development of a resource bank of occupational therapy for use in primary schools (Hutton, 2009), supporting the collaborative model of intervention. in the Australian context, the Queensland Department of Education (2012) has provided guidelines for management and provision of Speech and Language Therapy services at state level, region level and local school level to support inclusion for students. Similar programs to support Speech and Language, Psychology services and Vision and Hearing support exist within all states, but there are no collaborative models for occupational therapy services. Since the SDAC reported that 83.7% children with autism and intellectual disability needed different types of support at school and more than 44.1% students did not receive all the support they needed (Australian Bureau of Statistics, 2015); this indicates a need for more collaborative models to provide necessary support for therapies beyond speech & language, vision and psychological services, such as occupational therapy, to support students and foster inclusion.

A study of classroom based interventions for students with autism and other developmental and intellectual disabilities indicated that teacher training is a systems-based challenge that has an impact on learning outcomes for students (K. & Dunlap, 2001; Koegel et al., 2012). Recommendations for improving outcomes for students having issues with engagement, communication, social interactions, and challenging behaviours were: adequate training in interventions, consistent team work between educators, therapists and parents, and transferring the interventions across multiple settings (Boyer & Lee, 2001; Busby, Ingram, Bowron, Oliver, & Lyons, 2012; Campbell et al., 2012; Koegel et al., 2012; Machalicek, O'Reilly, Beretvas, Sigafoos, & Lancioni, 2007; Missiuna et al., 2012; Robertson, Chamberlain, & Kasari, 2003; Robinson, 2017; Villeneuve & Shulha, 2012).

Research into interventions employed in inclusive general education classrooms indicated that teaching functional communication, self-management, and instructional strategies such as pre-task sequencing, pivotal response training, and so forth assisted in increasing task engagement. These interventions also facilitated peer interactions, peer modelling, increasing social motivation, increasing social initiation, appropriate social responding, and decreasing interrupting behaviours increased the chances and success of social interactions (Crosland & Dunlap, 2012; Goodman & Williams, 2007; Koegel et al., 2012; Williams White, Keonig, & Scahill, 2007). The literature from Brosnan and Healy (2011); Machalicek et al. (2007); Matson and Shoemaker (2009); Matson et al. (2011); Visser, Berger, Prins, Van Schrojenstein Lantman-De Valk, and Teunisse (2014) indicated that challenging behaviours had a significant impact on communication, social interactions, and task engagement for students with autism, developmental disability, and intellectual disability.

It has been found that challenging behaviours, especially aggression, were a common feature in children and adults with autism and intellectual disability (Brosnan & Healy, 2011; Machalicek et al., 2007; Matson & Shoemaker, 2009; Matson et al., 2011), and such behaviours continue to be a major barrier to social and task engagement (Machalicek et al., 2007; Visser et al., 2014). Research indicated that aggression was most commonly observed as a result of difficulties in shifting attention between tasks, topics, persons, and places; these difficulties being features of autism, intellectual disability, and developmental disability (Brosnan & Healy, 2011; Matson & Jang, 2014; Visser et al., 2014). While there are several medication-based interventions currently employed to manage challenging behaviours, a comprehensive review of interventions suggests that a cognitive-behavioural model of intervention may be more successful in reducing such behaviours (Matson & Jang, 2014; Matson et al., 2011).

Other interventions employed to manage challenging behaviours have been antecedent based methods such as social stories, video modelling, cue cards, and exercise. Outcomes of these studies indicated that any change in behaviours appeared to depend on the baseline levels of behaviours and varied individually (Machalicek et al., 2007). Change in classroom-based instructional context, such as using a therapy ball for students to sit on, customising classroom instruction and making an instruction schedule, prompting strategies, embedded instruction, and so forth, all had positive outcomes (Hess, Morrier, Heflin, & Ivey, 2008; Machalicek et al., 2007).

What is sensory integration?

As discussed above, there are varying interpretations of what sensory integration is and what sensory integration intervention is. In recent years, effort has been made to clarify the terms ‘sensory integration’ and ‘sensory integration intervention’. As a result, now, there is the trademarked term Sensory Integration®, that adheres to Ayres’ principles of sensory integration in theory and implementation, which is accompanied with a Fidelity Measure to ensure fidelity of the intervention (Smith Roley et al., 2007).

A survey of intervention strategies used across all school levels, preschool to high school, and across general education, mixed, and special schools, indicated that intervention using sensory integration is deemed promising and is employed in more than 90% of instances (Hess et al., 2008; Rogers & Ozonoff, 2005). This popularity was despite a paucity of rigorous research into sensory integration intervention. There was, however, a lack of clear understanding of what sensory integration meant (Bundy & Murray, 2002). It is described as a spiral process of self-actualization that incorporated inner drive, sensory intake, sensory processing, and adaptive behaviour in response to sensory intake (Fisher & Murray, 1991), and as an automatic, integrated experience of mind and body that is mediated by the central nervous system (Kielhofner & Fisher, 1991). Sensory integration is also defined as a formulation of behaviour through computation of inputs from multiple senses (Lawson, 2013), and as a synchronous processing of information within two or more sensory cortices of the brain (Collignon et al., 2013).

As has been discussed, sensory processing within individual sensory systems is challenging for people with autism, who also have difficulties unifying information from more than one sensory system (Marco et al., 2011a). Multiple studies report reduced responses from children with autism when presented with auditory and visual stimuli simultaneously (Courchesne et al., 1985; Courchesne et al., 1989). It has also been observed that there is an atypical sequence affecting the latency and magnitude of neural activity when processing information from multiple sensory systems (Russo et al., 2010). In groups and in crowded social situations, when one has to focus on auditory messages, it was typical for individuals to rely on visual processing through lip reading or facial expression to supplement the disturbance in auditory information. For children with autism however, this augmented multisensory processing is a deficit (Foxe et al., 2013; Iarocci, Rombough, Yager, Weeks, & Chua, 2010; Russo et al., 2010; Stevenson, Segers, Ferber, Barense, & Wallace, 2015).

There are few interventions that specifically address sensory processing difficulties for children with autism and intellectual disability. The literature viewed thus far has established a link between sensory processing difficulty and observed behaviours that may impact classroom engagement and the learning process of children with autism and intellectual disability; for example, a child struggling to focus on teacher instruction in a busy classroom, or a child struggling to transition between consecutive lessons (Ashburner et al., 2014; Ashburner et al., 2008).

There are three sensory-based interventions that exclusively address sensory processing and arousal difficulties: sensory-motor interventions such as the sensory diet, the Alert programme®, and sensory integration (SI) (Ayres, 1972, 1989; Kawar, 2002; Wilbarger & Wilbarger, 2002; Williams & Shellenberger, 2002). Of these, the

Alert programme® depends on a cognitive awareness in conjunction with sensory strategies to support behaviour and learning, as well as supporting individuals to self-regulate their levels of sensory arousal; while other programmes such as the Wilbarger Approach or the Vestibular-Occulomotor Protocol focused on passive participation in sensory stimulatory activities and protocols (Kawar, 2002; Smith Roley et al., 2007; Wilbarger & Wilbarger, 2002).

SI intervention is the only one of these that evaluates an individual's needbased on a systematic assessment of multiple sensory systems by qualified OTs to develop a sequence of activities targeted to improve individual outcomes and to develop skills. For this reason and for the purpose of this study, the researcher adapted the intervention based on Ayres' theory of sensory integration (ASI) intervention for use in a special school with a moderate sample of children with a dual diagnosis of autism and intellectual disability (Ayres, 1972, 1976, 1978, 1980). It is important to acknowledge that the ASI® was not originally intended for implementation in a classroom atmosphere due to limitations around space and equipment.

Theoretical framework for sensory integration and learning

Sensory integration is defined as an unconscious process of the brain that organizes information provided by all senses, making any experience meaningful and allowing us to act or respond appropriately to a situation, purposefully forming an adaptive response (Ayres, 1972). It is also the basis of self-management and organisation towards developing functional skills (Humphry, 2002). This process forms an underlying foundation for academic learning and social behaviour by enabling attention to task, acquisition of skills, application of knowledge, attainment of fluency and automaticity, and an ability to generalize knowledge and skills across situations, with adaptations being made when necessary (Westwood, 2004). Such skills, of which sensory integration was foundational, were highlighted as important components of various theories of learning including: stages of cognitive development (Piaget, 2013), and operant learning by Skinner, (1937) as cited in (Reese, Howard, & Reese, 1978), social learning theory by Bandura, (1977, 1986), sociocultural theory of cognitive development by Vygotsky, (1978), and information processing (schema) theory by Miller, (1956) all cited in (Vaughn & Bos, 2009). These theories of learning, and where sensory integration fits within each theory, are discussed in brief in this section.

In the stages of development outlined by Piaget there were four factors involved in acquisition of knowledge or learning: maturation of the nervous system, how the child's experience of his or her physical environment affects the structure of intelligence, social transmission (such as language), educational transmission, and equilibration and self-regulation (Piaget, 1964). Piaget's theory was based on the developmental stages of the child as his or her nervous system matured, the effect of playful and learning experiences of the child, and the information received by the child to make sense of those experiences at each level of understanding (from basic to complex levels). Piaget theorised that each level of understanding and knowledge had to be satisfied completely before the learning went to the next level of understanding, a process that Piaget termed as "equilibration". Piaget's theory was based on the natural developmental process or "maturation" of the nervous system.

The operant conditioning theory (or operant learning) by Skinner (1937) proposed that positive or negative reinforcement trained an individual by altering his or her behaviour through shaping or modifying that behaviour (Reese et al., 1978). This theory implied that experiences, positive or negative, altered a child's behaviour according to the child's perception of those experiences. Instruction based on this theory was supposed to be highly adaptable for the classroom to increase skill acquisition by students and decrease disruptive behaviours in the classroom. However, it relied on the child's behavioural response to the experiences that determined if the experiences were positive (reinforcers) or negative (deterrents) for learning to occur (expressed as shaping of behaviour or behaviour modification) (Reese et al., 1978), and it did not explain all of the cognitive processes involved in learning. The child's perception of experiences as reinforcers or deterrents might be influenced by neurological activation within the brain areas of reward mechanism and motivation (Mazefsky et al., 2013; Ruff & Fehr, 2014).

The social learning theory proposed that children were able to learn only when they were focused on a task (attention), were able to internalise information (retention), were able to reproduce a previously learned skill or knowledge, and were able to do all of these only when highly motivated (Bandura, 1977). Hence, the neurological network involved in the social learning theory was the same as those involved in task engagement, continued attention to task and finding the tasks engaging (Danzl et al., 2012; Pisha & Coyne, 2001).

The sociocultural theory of learning proposed that a child's cognitive development and learning occurred as a result of the child's social experiences and interactions with language (Vygotsky, 1980). Vygotsky theorised that the basic mental functions of a child, such as attention, sensation, perception, and memory, developed to a higher order when the child interacted in a rich socio-cultural environment. In spite of the contrast between Vygotsky's theory (socio-cultural experiences lead to learning and development) and Piaget's theory (development precedes and facilitates learning), both involved development and maturation of the nervous system, whether as a cause or effect of learning.

The information processing model, as hypothesized by Miller (1956), was based on a child creating "schemas" (learning blocks) from any new experience, skill, and knowledge, and these schemas were based on prior learning (Axelrod, 1973). The information processing theory involved cognitive processes such as perception, recognition, imagining, remembering, thinking, judging, reasoning, problem solving, conceptualizing, and planning (Vaughn & Bos, 2009), with these cognitive processes occurring within the different cortical areas of the brain. As examined previously, memory skills, social motivation, self-regulation, decision making and moral behaviour (Assaf et al., 2013; Axelrod, 1973; Barrasso-Catanzaro & Eslinger, 2016; Bernhardt et al., 2014; Carré et al., 2015; Chen et al., 2015; Goddard et al., 2016; Greimel et al., 2012; Williams, Goldstein, et al., 2005)

The above-mentioned teaching and learning theories involved the sensory systems and sensory processing as they include developmental stages and cognitive processes, such as perception, memory, and so forth. Building on prior learning to acquire new skills and knowledge, as suggested by the afore-mentioned learning theories is made possible with sensory integration, when different pieces of information processed in different brain areas is integrated to make sense (Collignon et al., 2013; Kielhofner & Fisher, 1991; Lawson, 2013).

Sensory integration intervention

Development of sensory integration intervention

Ayres (Ayres, 1972, 1976, 1978, 1980) proposed the SI theory and tested it at various times (Ayres, 1972, 1976, 1978, 1980) on children with sensory integration dysfunction and auditory language problems. Ayres and Tickle (1980) found that their participants with autism and SPD made significant gains in reading and auditory language even though these were not the targeted variables of the study. Hyper-reactive children in this study indicated more gains compared to hypo-reactive children. This indicated that the ASI® (Smith Roley et al., 2007) had a more direct impact on sensory modulation than on registration or orientating to the sensory stimuli. This study proposed a hypothesis that vestibular and tactile input influenced other sensory systems such as the auditory system which improved vocabulary and reading. Ayres' testing was based on the principle of changing a child's sensory systems by using an intervention programme consisting of two stages. Prior to 1980s, A. Jean Ayres used the Southern California Sensory Integration Tests (SCSIT) to assess the children and identify any sensory processing disorder; in late 1980s the Sensory Integration and Praxis Tests were developed for assessment of sensory processing difficulty (Ayres, 1989; Mailloux, 1990) so that intervention could be developed keeping in mind the child's individual needs.

The first stage is a clinical assessment of the child, using the Sensory Integration and Praxis Tests (SIPT) to determine whether SI intervention would be appropriate for the child (Ayres, 1989). The SIPT consists of a battery of tests conducted for children between four years to eight years and eleven months of age, over a period of two hours. The SIPT scores identified the underlying difficulties in a child's sensory systems that impacted the child's learning behaviours in terms of seventeen domains: space visualization, figure-ground perception, standing/walking balance, design copying, postural praxis, bilateral motor coordination, praxis on verbal command, constructional praxis, postrotary nystagmus, motor accuracy, sequencing praxis, oral praxis, manual form perception, kinesthesia, finger identification, graphesthesia, and localization of tactile stimuli. Each domain could be tested separately over ten minutes if the child was not able to stay focused on task for the necessary two hours to administer the entire battery of tests. The child's performance scores in each of these domains were then compared against the national norms derived from testing over two thousand age-matched children.

The second stage of the process would be the intervention which involved the therapist planning a series of personalised intervention activities aimed at addressing a child's specific sensory difficulties within any or all of the seventeen domains (Ayres, 1989; Mailloux, 1990). The planned activities ensured that the child would receive plenty of proprioceptive, tactile, and vestibular feedback while working through the increasingly complex planning to complete the activity (Ayres, 1989; Bundy & Murray, 2002).

There are other sensory integration-based interventions, such as brushing and sensory diets (Wilbarger & Wilbarger, 2002) and the Alert program® for self-regulation (Powell, 2013; Williams & Shellenberger, 2002). However, they do not target all elements of SI intervention identified by the Fidelity Measure for Ayres' SI® (Parham et al., 2011). SI intervention and sensorimotor intervention (Miller, Wilbarger, & Stackhouse, 2002/2007) were both based on gross-motor activities, although they are distinct from one another. The sensorimotor intervention was therapist directed, involved groups of children and was highly structured in nature, whereas SI intervention was self-directed (by the child) and kept flexible to suit individual needs by a therapist (Anzalone & Murray, 2002). The difference between the two was that a SI intervention uniquely used suspension equipment and graded multisensory input as antecedents, targeting the vestibular, proprioceptive, and tactile sensory systems through activities. The presence of all the ten elements of the Fidelity Measure (Parham et al., 2011) distinguishes SI intervention from sensorimotor intervention.

Theoretical framework for sensory integration intervention

Earlier in this chapter neurophysiological differences regarding the structure, connectivity, and activation patterns of the autistic brain were discussed. It is useful to look at some bottom-up intervention that is aimed at improving the process of sensory integration in order to improve learning outcomes, such as outlined by afore-mentioned theories of learning for students with autism.

Given the importance of sensory integration as a foundation for critical skills emphasized throughout theories of learning, in addition to its role as a valid predictor of learning outcomes (Parham, 2002), it is imperative that educators have a basic understanding of sensory integration theory itself, before implementing a sensory integration programme (SI intervention). The sensory integration (SI) theory is defined as “the neurological process of organizing sensory input so that the brain produces a useful body response and useful perceptions, emotions and thoughts”

(Ayres, 1980, p. 28). This theory is based on three assumptions (Bundy & Murray, 2002):

1. Learning is dependent on information received by the senses from the environment and this information is used to form an adaptive response.
2. Individuals with dysfunctional ability in processing sensation also have difficulty in producing appropriate responses.
3. Increased sensation through meaningful activities improves the ability to process sensation, thus leading to better adaptive behaviour.

The assumptions of SI theory have informed the development of sensory integration programmes used throughout clinics internationally for children with a variety of special education needs (Ayres, 1972; Ayres & Tickle, 1980; Parham, 2002). Meaningful activities referred to in SI theory are translated into practice by focusing on the vestibular, proprioceptive, and tactile sensory systems. These activities can include rolling, jumping, bouncing, and swinging with the help of suspension equipment (Koomar & Bundy, 1991). It is important that the activities are meaningful to the child and are self-directed. It is also vital that the activities are success oriented, yet present a “just-right challenge” (Koomar & Bundy, 1991), which is described as one that supports a child to strive and reach a goal, but is not so difficult that the child becomes frustrated and gives up. This challenge can be maintained by being vigilant of the child’s response to signs of stress and by modifying the activity in frequency, duration, intensity, and complexity (Koomar & Bundy, 1991). A SI intervention should ideally be administered for 30-40 minutes, three to four times a week over a period of six months to one year (two if required) (Koomar & Bundy, 1991).

Fidelity of sensory integration intervention

The wide interpretation of the term "sensory integration" highlighted a need to develop guidelines to maintain fidelity of a SI programme, and so a fidelity tool was developed to address inconsistencies in sensory integration intervention.

The Ayres Sensory Integration® Fidelity Measure (Parham et al., 2007; Parham et al., 2011) defined SI intervention and operationalised the intervention for the practitioner of SI intervention. Prior to this, the STEP-SI model (Miller et al., 2002/2007), based on sensory input, task requirements, environment modification, predictability of routines, self-monitoring, and supportive interactions, helped to individualize SI intervention programmes. At the commencement of this present study, the Fidelity Measure and the training for it was not available to the researcher, hence the researcher used the available literature about the Fidelity Measure and developed a checklist (Parham et al., 2007; Parham et al., 2011) to implement a SI intervention programme. For consistency of understanding, the intervention or treatment in the present study will be referred to as a sensory integration programme (SI intervention).

Meta-analyses for sensory integration intervention

Ayres' hypothesis was that a sensory integration intervention brings about a change in a child's central nervous system, thereby influencing his or her sensory processing (Ayres, 1979). This hypothesis may be supported by the principle of neuroplasticity in recent research (Mottron, Belleville, Rouleau, & Collignon, 2014; Moucha & Kilgard, 2006). The study of sensory integration intervention has not yet extended into classroom-based research or into neurological investigation. The last four decades have widely examined the effects of SI intervention in clinical settings, and for children with a wide range of developmental conditions, with varying outcomes, as described below.

Recent meta-analysis of research on SI intervention (Leong et al., 2015) examined the effect on 1434 individuals, of both genders, aged between 0 and 18 years, by reviewing 30 comparison group studies on sensory integration intervention for people with intellectual disability, learning disability, autism, and other disabilities. The analysis on sensory integration intervention, which is termed “sensory integration therapy” in the study, revealed a significant but small effect of the intervention when compared to no treatment. However it found a non-significant result when compared to other interventions. This study concluded that intervention by sensory integration therapy (Leong et al., 2015) should not be recommended outside a research context, even though it has been widely implemented in clinical contexts. The authors of this meta-analysis had several reservations: questioning the fidelity of the treatment, lack of documentation to support replication of the treatment programme, poor quality of research methodology used, diverse and multiple outcome variables, and the wide range of disabilities in the inclusion criteria being addressed by the treatment.

Leong et al. (2015) concluded that intervention using sensory integration therapy required further evaluation within research contexts and suggested that researchers pay particular attention to fidelity, have accurate and clear documentation to enable replication, use a rigorous research methodology, have specific and defined outcome variables, and narrowly focus on disability type per research design. These cautionary measures were reiterated by other researchers (Case-Smith & Arbesman, 2008; Harvey, 2013). Case-Smith and Arbesman (2008) noted that SI intervention enhanced the children's ability to modulate their behaviour, participate in play, reduce sensitivity, and participate in social interactions. The study also suggested positive outcomes were based on certain characteristics shared by SI intervention and other intervention approaches: creating a stimulating environment that also promoted social interactions, setting up a just-right challenge, providing positive social reinforcement, and allowing the child extra time to formulate their response. However, the study also reported a small sample size and a lack of control groups in the studies.

Another systematic review investigated five studies involving SI therapy and 14 studies involving sensory-based intervention between 2000 and 2012 for children with autism and coexisting sensory difficulties (Case-Smith et al., 2014). Of these, two randomised controlled trials had a low- to moderate-positive effect (Cohen's *d*, between 0.72-1.62) for SI intervention. When the SI intervention was based in a clinic with an environment enriched with sensory feedback and child-initiated activities, improvement was observed in individualised parent determined goals using Goal Attainment Scales (Mailloux et al., 2007). The non-randomised studies investigating effects of SI therapy found reduced problem behaviours one hour after SI therapy (p = 0.02) compared to one hour after behavioural intervention. The same studies also found significantly decreased problem behaviours from week 1 to week 4 (p = 0.04). The investigation of the 14 studies involving sensory-based intervention found that the use of single items in classroom-based strategies (such as wearing a weighted vest; sitting on a therapy ball; various forms of vestibular stimulation by bouncing or swinging; and a sensory diet of brushing, swinging and jumping) on the child's levels of arousal did not provide consistent positive results as a result of intervention. Hence, Case-Smith et al. (2014) recommended further investigation into the efficacy of SI intervention by using randomised control trials.

Other reviews (e.g.Barton, Reichow, Schnitz, Smith, & Sherlock, 2015; Lang et al., 2012; May-Benson & Koomar, 2010) studied the effect of SI intervention on children with issues of sensory processing and sensory modulation, with or without some form of learning disability, but they did not specifically study the effect of SI intervention on children with ASD. These reviews reported gains in sensorimotor skills, motor planning, socialisation, attention, and regulatory behaviours when exposed to SI intervention.

Barton et al. (2015) reviewed 30 studies with a total of 856 participants for the effect of sensory-based interventions, such as swinging, deep pressure, therapy balls, sensory diet, brushing protocol (Wilbarger & Wilbarger, 2002), chewy tubes, specialised seating, and so on. Some of the studies in Barton's review (2015) explained in great detail how the materials were used, whereas others had little detail. The studies varied in the duration of intervention sessions from 4 to 240 minutes, the frequency of sessions varied from 5 to 20 sessions when reported, and the reported length of the entire intervention period varied from ten days to twelve months. A well-documented protocol, to ensure fidelity of intervention, was employed in only 11 studies. Half of the investigated studies used a group design and the other half employed a single case design. The group design studies exposed a high risk of performance bias (100%) and lack of fidelity (73%), while the single case studies exposed a high degree of performance bias due to lack of fidelity (100%). Overall, the review by Barton et al. (2015) reported a paucity of consistent positive outcomes in the reviewed studies and exposed a lack of rigor and consistency in the research designs and methods of intervention. The review recommended using effective neurological measures to establish a causal relationship between sensory-based intervention and outcomes.

Lang et al. (2012) systematically reviewed twenty-five studies that investigated efficacy of intervention with SI therapy for children with diagnoses of autism, Asperger's syndrome, or Pervasive Development Disorder, Not Otherwise Specified (PDD-NOS). The studies investigated the effect of intervention on various target behaviours, such as self-stimulation and stereotypical behaviours (six studies), language and communication skills (four studies), and social skills and emotional behaviours (four studies). They investigated additional behaviours such as task engagement, focus, sharing joint-attention with a partner, problem behaviours, and so forth. Intervention techniques reviewed included using a weighted vest, brushing, joint compression and stretching, swinging and rocking. In occupational therapy, a weighted vest is used to apply pressure and calm children who need added proprieoceptive feedback or are prone to anxiety and stress. There is a general guideline of limiting the added weight to 5% of the child's body weight and wearing it for not more than one hour at a time (Dunn, 1997). The review reported fourteen studies with no efficacy of intervention with this version of SI therapy, eight studies with mixed results, and only three with positive outcomes. Even these three studies demonstrated a low level of certainty due to the inconsistent design issues. Overall, the review did not find consistent positive outcomes from a sensory integration intervention.

May-Benson and Koomar (2010) reviewed twenty-seven studies that investigated effects of a sensory integration intervention on children with learning disabilities, autism, motor delays, sensory modulation disorders, developmental coordination disorders, and neurological disorders. Intervention sessions varied in frequency from one to five per week and the duration varied from one week to twelve months. The total intervention time varied from 5 to 72 hours. When compared to children who had no intervention, this evidence-based review indicated positive outcomes in sensorimotor skills, motor planning, socialisation, attention, regulation of behaviour, and reading skills. When a sensory integration intervention was compared with alternative interventions, such as perceptual-motor based activities, the review found that positive outcomes were more sustainable for sensory integration intervention. The review recommended more quantitative and qualitative studies to investigate the efficacy of sensory integration intervention.

Meta-analysis by Vargas and Camilli (1999) included twenty-seven studies from 1972-1997, including eight studies reviewed earlier by Ottenbacher (1982), and compared the effect of sensory integration intervention to those of no treatment and of alternate treatment. In reviewing earlier studies (1972-1982), Vargas and Camilli (1999) found positive gains in sensorimotor skills and motor planning, socialization, attention and behaviour regulation, reading skills, participation in active play, and achievement of individual goals; replicating findings from Ottenbacher (1982). They found that gains made in gross motor skills, self-esteem, and reading were sustained from three months to two years. In the review of later studies (1983-1997), in studies with positive effect, larger effect sizes were observed in psycho-educational measures (such as language skills, memory, eye-hand coordination, attention, planning ability, and academic skills, such as reading, writing, spelling and mathematics) and motor measures (movement, strength, planning, agility, and so forth).

A more recent investigation into the efficacy of Ayres' SI® (ASI) intervention has produced additional evidence (Schaaf, Dumont, Arbesman, & May-Benson, 2018; Schoen et al., 2019). Schaaf and colleagues (Schaaf et al., 2018) examined five studies between 2007 and 2015 that used ASI® intervention for children with autism. Two of the studies included used the manualised protocol outlined by the ASI Fidelity Measure (ASIFM) (Parham et al., 2007; Parham et al., 2011), while the remaining three followed the principles of ASI® as closely as possible. The results of this systematic review provided strong evidence for improving individual goals around functioning and participation using Goal Attainment Scaling (Mailloux et al., 2007), moderate evidence for improvement in autistic behaviours and reduced assistance by care-givers. There was limited evidence of changes in language development, social skills and play (Schaaf et al., 2018). Schoen et al. (2019) scanned studies between 2006 – 2015 and identified three studies that met the CEC standards for evidence-based practices in special education (CEC, 2014). Schoen et al. (2019) confirmed the following elements: the context and setting met the ASI® fidelity measure; participants with autism and ID who also had sensory processing difficulties; sensory integration trained implementation personnel; clearly operationalised intervention procedure; applied fidelity elements or used the fidelity measure (Parham et al., 2011); the studies maintained internal validity by applying experimenter control over the independent variable which was ASI®; clearly defined outcome measures were used; appropriate data analysis techniques to ensure change and use of calculated effect sizes (i.e. partial η^2). The review concluded that ASI® intervention may be considered as an evidence-based intervention for children with autism who experienced difficulties with sensory processing and/or sensory modulation (Schoen et al., 2019).The above discussion highlights similarities and differences between the various studies reviewed. The discussion also indicates inconsistencies around a wide variety of selection criteria employed in the studies, such as interpretation of what sensory integration means, the age of participants, disability criteria for inclusion, and inconsistency of rigor among the research designs. For example, reviews by Case-Smith and Arbesman (2008) and Lang et al. (2012) included studies where therapists employed sensory integration principles (being based on gross motor activities) but did not adhere to the principles in the use of suspension equipment or by providing activities with vestibular, proprioceptive, and tactile feedback. These inconsistencies throw significant doubt on conclusions drawn about SI intervention.

Systematic review of research on sensory integration intervention

Meta-analyses of literature as illustrated above, on sensory integration intervention revealed a tendency to examine the same twenty to thirty studies and to raise concerns of methodological issues. There has been effort to address the perceived lack of rigorous study and to introduce a fidelity protocol for the sensory integration intervention (Noddings, 2012; Parham et al., 2011; Ragonese, 2008). Studies that reflect such efforts are the basis for this research.

Summary of research on outcomes of sensory integration intervention

Twenty three studies targeting the efficacy of sensory integration interventions have been identified as relevant to this research, as they involved participants diagnosed with autism displaying high sensory needs. Miller et al. (2007) is included, despite participants having diagnoses other than autism, because all had a common diagnosis of sensory modulation disorder (SMD). Table 2-1 summarizes the papers studied.

Table 2-1. *Summary of sensory integration intervention literature for children with autism*

Author	Year	Participants n= (age) Diagnoses	Method	Type of intervention (Setting)	Findings
Ayres & Tickle	*1980*	*10 (3-13 years)* *Autism*	*Initial evaluation followed by individual subject changes*	*Touch, vestibular stimulation (clinical setting)*	*Therapeutic procedures more effective on hyper-reactive children (p < 0.05)*
Riley, et al.	*1983*	*18 (6-12 years)* *Autism*	*Single subject* *Comparison of two treatments*	*Swinging on a bolster swing and bouncing* *(setting not mentioned)*	*Fine motor table top activities elicited more variety of speech (p = 0.05), longer sentences (p = 0.01) and less autistic speech (p = 0.04)*
Larrington	*1987*	*1 (15 years)* *Autism & ID*	*Case study*	*Vibration, weighted vest/lap robe, scooter board, trampoline* *(home setting)*	*Increased calmness, improved posture, and so forth. Decreased self-harm*
Ray, et al.	*1988*	*1 (9 years)* *Autism & DD*	*Pre-, post-stimulation and during stimulation period*	*Vestibular stimulation, platform swing with bouncer attachment* *(therapy room)*	*Increased vocalizations during stimulation, acquired 13 new words during 4 weeks of treatment*
McClure & Holtz-Yotz	*1991*	*1 (13 years)* *Autism & ID*	*Case report*	*Arm splints, vestibular stimulation, warm baths* *(clinical setting)*	*Decreased self-stimulation and self-injurious behaviour, increased ability to interact with others*
Zisserman	*1992*	*1 (8 years)* *Autism, seizures, DD*	*Case report*	*Deep pressure with gloves and pressure garment* *(classroom setting)*	*Decreased self-stimulation with garment/gloves on, finding did not transfer into classroom after garment/glove was taken off*
Linderman & Stewart	*1998*	*2 (3 years)* *PDD*	*Single subject AB design*	*Sensory integration-based occupational therapy* *(clinical setting)*	*Significant improvement in social interactions (SD = 0.31)(SD = 0.35), approaching new activities (SD = 0.71), response to holding, hugging and movement (SD = 0.35) (SD = 0.52)*
Case-Smith & Bryan	*1999*	*5 (4-5 years)* *Autism*	*Single subject AB design*	*Sensory integration intervention activities based on Ayres' principles* *(preschool setting)*	*Decrease in non-engaged behaviour (4 students; p = 0.011, p = 0.036, p = 0.024, p = 0.036), increase in goal-directed play (3 students; p = 0.025, p = 0.0.11, p = 0.003), no effect on interaction with*

					adults or peers
Fertel-Daly et al.	*2001*	*5 (2-4 years) PDD*	*Single subject ABA design*	*Weighted vests (preschool setting)*	*Increased attention to task, decreased self-stimulating behaviour, decreased distracting behaviour as found by comparing phase means*
Smith,et al.	*2005*	*7 (8-19 years) PDD & ID*	*Single subject ABAB design*	*Sensory integration intervention vs control intervention (residential setting)*	*Self-stimulating behaviours reduced 11% (p = 0.02) more after sensory integration activities compared to control activities*
Miller, et al.	*2007*	*24 (6-7 years) SMD*	*Alternating treatment design*	*OT sensory integration intervention, control treatment, no treatment (clinical setting)*	*Significant gains on GAS, Attention subtest and Cognitive/Social composite of the Leiter Scale-Revised (p = 0.03) compared to no treatment, (p = 0.07) compared to other treatment*
Schaaf & Nightlinger	*2007*	*1 (4 years) SPD*	*Case study*	*OT sensory integration intervention (therapy setting)*	*Notable improvements on GAS, increased participation at home, school and family activities*
Watling & Dietz	*2007*	*4 (3-5 years) Autism*	*Single subject ABAB design*	*Ayres' sensory integration intervention and play scenario (clinical setting)*	*No substantially different effect on undesired behaviours and engagement*
Schoener, et al.	*2008*	*1 (18 years) Autism & SLD*	*Case report*	*Sensory integration intervention (treatment room at school)*	*Reported and observed increased motor skills*
Reichow, et al.	*2009*	*3 (4-5 years) Autism & DD*	*Alternating treatment design*	*Use of weighted vests (school setting)*	*Null findings*
Devlin, et al.	*2009*	*1 (10 years) Autism*	*Alternating treatment design*	*Sensory integration intervention and behaviour therapy (school setting)*	*Results from behaviour intervention were more on self-injurious behaviour than sensory intervention*
Bonggat & Hall	*2010*	*3 (4-5 years) Autism (2) & DD (1)*	*Alternating treatment design*	*Sensory integration intervention-based activities and attention control (preschool setting)*	*No difference in estimated percentages of time on task in either treatment*
Pfeiffer, et al.	*2011*	*37 (5-12 years)*	*Comparison study*	*Sensory integration intervention activities and fine*	*More significant changes on GAS for SI group compared to fine motor group (control) (p<0.05*

		Autism		*motor activities (therapeutic activity programme)*	*parent-reported, p<0.01 teacher-reported), significant decrease in autistic behaviours in SI group (p<0.05)*
Devlin, et al.	*2011*	*4 (6-11 years)* *Autism*	*Alternating treatment design*	*Sensory integration treatment and behaviour intervention (classroom setting)*	*Decreased challenging behaviours in behaviour intervention phase compared to SI phase*
Schaaf, et al.	*2014*	*32 (4-8 years)* *Autism*	*Randomised control trial design*	*OT sensory integration intervention treatment (clinical setting)*	*OT SI group scored significantly higher on GAS (p = 0.003), improved outcomes for self-care (p = 0.008) and socialization (p = 0.04)*
Mills & Chapparo	*2016*	*1 (8 years)* *Autism, mild ID*	*Critical case study*	*Sensory Activity Schedule based on Sensory Diet* *(classroom setting)*	*Challenging behaviour incidents reduced (83 to 14)*
Mills, et al.	*2016*	*4 (5-8 years)* *Autism, ID*	*AB single system research design*	*Sensory Activity Schedule based on Sensory Diet*	*Significant total PRPP task analysis scores for 3 out of 4 students (p = 0.038, 0.004, 0.002)*
Mills & Chapparo	*2017*	*7 (5-8 years)* *Autism, ID*	*AB single system research design*	*Sensory Activity Schedule based on Sensory Diet*	*Significant total PRPP task analysis scores for 2 out of 7 students (p = 0.012, 0.001), clinically significant scores for 3 students (p = 0.074, 0.340, 0.570)*

Note: GAS – Goal attainment scales. Perceive, Recall, Plan, Perform (PRPP) task analysis (Chapparo & Ranka, 2006). Also refer to the Glossary.

Twelve of the twenty three studies in Table 2-1 used SI therapy developed by Ayres, and all reported some positive outcomes (Ayres & Tickle, 1980; Bonggat & Hall, 2010; Case-Smith & Bryan, 1999; Linderman & Stewart, 1999; Miller, Coll, & Schoen, 2007; Pfeiffer, Koenig, Kinnealey, Sheppard, & Henderson, 2011; Reilly, Nelson, & Bundy, 1983; Schaaf et al., 2014; Schaaf & Nightlinger, 2007; Shoener, Kinnealey, & Koenig, 2008; Smith, Press, Koenig, & Kinnealey, 2005; Watling & Dietz, 2007). Other studies (Fertel-Daly, Bedell, & Hinojosa, 2001; Larrington, 1987; McClure & Holtz-Yotz, 1991; Reichow, Barton, Sewell, Good, & Wolery, 2009; Reilly et al., 1983; Zissermann, 1992) had some elements of SI intervention, such as using proprioceptive and vestibular elements, and all reported positive outcomes similar to the twelve studies mentioned earlier (for example, Ayres & Tickle, 1980). The remaining two studies compared effects of SI intervention and other interventions on self-injurious and challenging behaviours of children with autism , but found positive effects from other interventions compared to SI intervention (Devlin et al., 2011; Devlin et al., 2009). The latest three studies (Mills & Chapparo, 2016, 2017; Mills, Chapparo, & Hinitt, 2016) employed a classroom based sensory activity schedule and found positive outcomes on the task analysis scores for the participants.

Limited empirical evidence is available regarding the effect of SI intervention for children with autism in a classroom setting, and even less on differences in implementation by OTs, teachers supported by OTs, and by teachers alone. Hence it is necessary to understand the supporting and controversial evidence of effects of SI intervention on the classroom behaviours of children with autism in order to increase the quality and time of engagement with curriculum tasks. It must be remembered that effects of SI intervention may not be uniform across all participants, as children with autism have a considerable degree of variability in their behaviours and skills. It is also vital to note that ASI® was not originally intended as a classroom based intervention, though the changes in sensory processing and/or sensory modulation have an impact on classroom behaviours and learning outcomes.

Research supporting sensory integration intervention

Several studies reported increased desirable behaviours, particularly goal attainment, engagement, increased social behaviour (interactions and improved tolerance to touch by parents), and increased emotional regulation following SI intervention (Case-Smith & Bryan, 1999; Larrington, 1987; Linderman & Stewart, 1999; McClure & Holtz-Yotz, 1991; Mills & Chapparo, 2016, 2017; Mills et al., 2016; Pfeiffer et al., 2011; Ray, King, & Grandin, 1988; Reilly et al., 1983; Schaaf & Nightlinger, 2007). Several others reported decrease of undesirable behaviours (Fertel-Daly et al., 2001; Larrington, 1987; Linderman & Stewart, 1999; McClure & Holtz-Yotz, 1991; Shoener et al., 2008; Smith et al., 2005; Zissermann, 1992).

Goal attainment and engagement. Studies of SI intervention noted increased goal directed behaviour, decreased disengaged behaviour, improvement in goal-attainment scaling scores where the goals were: sensory processing or sensory regulation, functional fine-motor skills and social-emotional skills; and decreased frequency and duration of disruptive behaviour was also noted (Case-Smith & Bryan, 1999; Fertel-Daly et al., 2001; Pfeiffer et al., 2011; Schaaf & Nightlinger, 2007). Case-Smith and Bryan (1999) administered an AB design with sensory integration-based activities to a group of five children aged 4 to 5 years, and reported benefits including decreased disengaged behaviours in four participants and increased goal-directed behaviour in three participants. Fertel-Daly et al. (2001) investigated the effects of weighted vests on five 2- to 4-year-old children in a single case ABA design and found increased engaged behaviour, with an improved focus on task and a reduction in the number of distractions. Pfeiffer et al. (2011) randomly assigned 37 6 to 12-year-old children to a fine motor and sensory integration intervention group and administered pre- and post-test measures, and found significant improvement using Goal Attainment Scales (Mailloux et al., 2007) and increased ability to perform either fully or partially on a standardised neurological screening test (Mailloux et al., 2007). Schaaf and Nightlinger (2007) conducted a case study of an 8-year-old child using OT-led sensory integration treatment and reported a notable improvement on Goal Attainment Scales (Mailloux et al., 2007). Increased praxis and motor skills have been reported as a result of exposure to sensory integration intervention (Shoener et al., 2008). A more recent randomised controlled trial reported a significant improvement in goal attainment scales after 30 sessions of SI intervention (Schaaf et al., 2014).

Social behaviour. Several studies reported an improvement in social behaviours of their participants following sensory integration intervention (Fertel-Daly et al., 2001; Linderman & Stewart, 1999; Pfeiffer et al., 2011; Ray et al., 1988; Reilly et al., 1983; Schaaf & Nightlinger, 2007; Zissermann, 1992). Linderman and Stewart (1999) examined the effects of sensory integration-based occupational therapy for two 3-year-old boys with a diagnosis of Pervasive Developmental Disorder. This single subject study involved a two-week baseline phase followed by an eleven-week intervention at home. The participants showed significant improvement in social interaction, response to movement, hugging, and approaching new activities. However, the participants in this study had concurrent interventions, such as vitamins, speech therapy, and had started preschool, making it difficult to attribute the gains to the sensory integration intervention alone.

Other studies reported a decrease in distracting behaviours (Fertel-Daly et al., 2001), “decreased autistic mannerisms “ (Pfeiffer et al., 2011, p. 8), and parent-reported improved behaviour with increased ability to participate in activities at school and home (Schaaf & Nightlinger, 2007). Two other studies examined the effects of vestibular stimulation with swings and bouncing for an 18-year-old male (Reilly et al., 1983) and a 5-year-old male (Ray et al., 1988), and found increased amount and variety of vocalisation during and after the intervention.

Emotional regulation. Several studies reported on an improvement in emotional regulation after the exposure to sensory integration intervention (Fertel-Daly et al., 2001; Larrington, 1987; McClure & Holtz-Yotz, 1991; Smith et al., 2005; Zissermann, 1992). Larrington (1987) and McClure and Holtz-Yotz (1991) reported case studies of a 15-year-old and a 13-year-old respectively, with both participants receiving vestibular and proprioceptive stimulation, and reporting decreased self-injurious behaviours and increased calmness and interaction with others. All of the above-mentioned studies reported a decrease in self-stimulation and self-injurious behaviour. Shoener et al. (2008) examined the effects of sensory integration intervention on an 18-year-old male and reported a general increase in happiness and wellbeing for the participant. Similar findings were repeated in a study by Smith et al. (2005) along with greater body awareness, and improved muscle tone and self-esteem in seven boys with ages 8 to 18 years.

Research not supporting sensory integration intervention

To increase engagement with table-top activities in an inclusive classroom, Reichow et al. (2009) used weighted vests for three 4- to 5-year-old children using an alternating treatments design and, unlike Fertel-Daly et al. (2001) , found that this use was not effective. Bonggat and Hall (2010) found no difference in the percentage of time on task when they administered weighted vests to three 4-year-old children in an alternating treatment design. Watling and Dietz (2007) used SI therapy and play scenarios for four three-year-old participants in a single case ABAB design and, in contrast to other reports, reported inconclusive effects of therapy on undesirable behaviours. Other studies (Devlin et al., 2011; Devlin et al., 2009) found behavioural intervention more effective than SI intervention or found inconclusive results.

Such contradictory evidence seems to arise from studies that used a variety of interpretations of sensory integration intervention, had small sample sizes, used clinical settings (as opposed to natural environments), and had inconsistent design rigour. This suggests further investigation into the efficacy of sensory integration intervention for improving learning outcomes in terms of task engagement, social interaction and emotional behaviour is required (Leong et al., 2015).

Research design limitations

Design of the studies in Table 2-1 needed to include a design method, an ability to compare treatments, children with autism, fidelity (by focussing on the principles of sensory integration), reliability, and measurement of effects. Design method is important in study design. Recent reviews of intervention by sensory integration therapy (Case-Smith et al., 2014; Lang et al., 2012; Leong et al., 2015) and the NPDC report (Wong et al., 2015) have also talked about the design related issues involving lack of fidelity and rigour. Thus, research design of individual studies needed to be investigated. In the twenty studies analysed (Table 2-1), five employed case studies, two ABAB , two AB,, one ABA, and four alternating treatment designs; and two randomised controlled trials, two comparison studies, and two pre- and post-test design studies. As an AB design lacks the opportunity for replication or withdrawal, it is not considered an experimental design, rather a pre-experimental design. ABA and ABAB designs are types of withdrawal designs, although with limitations: (a) treatment effect may continue even after treatment is withdrawn (despite stopping the measurement of effects), (b) it may not be desirable for the target behaviour to return to baseline (for example, in cases of self-injury, aggression, and so forth), and (c) withdrawal of effective intervention may prove unethical in the case of dangerous behaviours (Richards, Taylor, & Ramasamy, 2013b). Therefore, ABA and ABAB are often not the design of choice under such circumstances.

When considering design method, the studies in Table 2-1 can be roughly divided into two parts: earlier studies, prior to the year 2000, and later studies, after 2001. As can be seen in Table 2-1, studies prior to the year 2000 employed a variety of research designs suited to the purpose of piloting new ideas for intervention; of the eight studies, three were based on case studies and two on pre-experimental AB designs. These studies created the basis for further research, as recommended for single case experimental designs (SCED) (Beeson & Robey, 2006). Applying the recommendations, the SCEDs should ensure rigor in the research designs, to ascertain if the positive outcomes from sensory integration intervention could be replicated for a larger cohort of participants with autism within a heterogeneous classroom environment (Kratochwill et al., 2010). From 2001, studies in Table 2-1 included one ABA design, two ABAB designs, four alternating treatment designs, one comparison study, two randomised controlled trials, and two case studies. The replication effect is most clearly observed in the ABAB design (Smith et al., 2005; Watling & Dietz, 2007) that demonstrates the effects of intervention with the first withdrawal of intervention and the second instalment of intervention, while it is observed only once in the ABA design (Fertel-Daly et al., 2001), making the ABAB design a more desirable design. While the replication effect helped to strengthen the research studies, dependent variables such as self-stimulating behaviours, self-injury or emotional regulation being under investigation, bring ethical issues about effect of withdrawing the treatment on reoccurrence of those injurious behaviours into the forefront (Richards, Taylor, & Ramasamy, 2013a).

The ability to compare effects of treatments is important. The studies selected for this literature review compared effect of intervention between two treatments, for example, by Miller et al. (2007) and Pfeiffer et al. (2011); the alternating treatment designs employed by Reichow et al. (2009), Devlin and Leader (2009), Devlin and Healy (2011); while Bonggat and Hall (2010) randomly assigned groups of participants to each treatment. The advantage of these designs was their ability to compare the effect of one treatment with another, while their disadvantages were the possibility of a “sequencing effect” (where the benefits of the first treatment are ascribed to the second) and the possibility of undesirable behaviours (such as self-injury, aggression to others, property destruction etc.) returning after changing from the useful treatment (Richards et al., 2013a, p. 171).

It is important to this research that participants with autism are studied. Fifteen of these studies from this literature review (Table 2-1) investigated effects of the sensory integration intervention on participants with autism. Some of these participants had other co-existing disabilities, such as speech and language delay, seizures, and intellectual disability. Five of these fifteen studies examined the effects on participants with autism and intellectual disability or with autism and developmental delay. One study was included because the participants had severe sensory modulation disorder which caused behaviours similar to those with SPD.

In studies of sensory integration intervention it is important to maintain fidelity by following Ayres' sensory integration principles (proprioceptive, vestibular, and tactile feedback with the use of suspension equipment). Of the twenty three studies (Table 2-1), five studies used Ayres' sensory integration principles (Case-Smith & Bryan, 1999; Linderman & Stewart, 1999; Miller, Coll, et al., 2007; Pfeiffer et al., 2011; Watling & Dietz, 2007), five studies employed a variation (such as using a weighted vest, arm splints, pressure gloves, and so forth) (Fertel-Daly et al., 2001; Larrington, 1987; McClure & Holtz-Yotz, 1991; Reichow et al., 2009; Zissermann, 1992), and the remaining ten studies utilised a different interpretation of the principles (Ayres & Tickle, 1980; Bonggat & Hall, 2010; Devlin et al., 2011; Devlin et al., 2009; Ray et al., 1988; Reilly et al., 1983; Schaaf et al., 2014; Schaaf & Nightlinger, 2007; Shoener et al., 2008; Smith et al., 2005). In some studies, the interventions did not consistently maintain fidelity because interventions were delivered by OTs who had not undergone specific training in ASI ((Schaaf & Nightlinger, 2005; Watling & Dietz, 2007; Devlin et al. 2009, 2011; Shoener et al., 2008; Bonggat & Hall, 2010). These studies did not adhere to all the structural elements regarding training of intervention agents, pre-assessment procedures for participant children, physical environment and SI intervention process elements (Parham et al., 2011). Only three studies (Miller et al., 2007; Pfeiffer et al., 2011; Schaaf et al., 2014) employed a documented protocol for sensory integration intervention based on Ayres' principles, while there was no mention of a prescribed protocol in the studies that employed the sensory integration intervention. Since the development of the ASI® Fidelity Measure (Parham et al., 2011) and subsequent training of OTs in ASI® principles, future reviews of ASI® literature will become stringent in selection of studies to be reviewed.

Reliability is a key element of study design. The "later" studies in Table 2-1 (after the year 2000) employed a variety of reliability measures to strengthen their studies. These measures were blinding on the person responsible for data collection and analysing the data (Pfeiffer et al., 2011; Shoener et al., 2008; Watling & Dietz, 2007), inter-observer agreement (Bonggat & Hall, 2010; Case-Smith & Bryan, 1999; Devlin et al., 2011; Devlin et al., 2009), inter-observer reliability (Linderman & Stewart, 1999), and (in one case) multiple persons reviewing the video-taped data (Miller, Coll, et al., 2007). Such reliability measures were absent in the "earlier" (before the year 2000) studies.

In any study it is important to be able to observe and measure the effects that were the object of the study. The studies in Table 2-1 included measures such as PRPP task analysis (Chapparo & Ranka, 2006), Goal Attainment Scales (Mailloux et al., 2007), functional behaviour outcome measures such as the Paediatric Evaluation of Disability Inventory and the Vineland Adaptive Behaviour Scales were examined along with biometric measures, such as salivary cortisol and electro-dermal skin response. More of these standardised measurements were observed among the "later" studies (after the year 2000) in Table 2-1 than “earlier” studies (before 2000). These “later” studies also demonstrated various methods of analysing the data, using calculated statistical significance and effect size, rather than a reliance on visual analysis of the “earlier” studies.

Summary

Literature discussed in this chapter indicated a link between distinct neurological underpinnings and unusual sensory responses, anxiety, and restricted and repetitive behaviours of children with autism. A review of EBPs and other intervention literature indicated limited research on interventions directly targeting sensory structures. Literature examining the effects of sensory integration intervention demonstrated a need for well-constructed research addressing the inconsistencies highlighted in that literature. Any future study of sensory integration intervention should employ a strong research design allowing for replication of effect, have more than one reliability measures, maintain fidelity to the intervention protocol, and use statistical measures, such as significance and effect size, to support its findings.

This thesis used a combination of two well-structured experimental designs, involved a large number of students within a consistent age range and diagnosis, using well-defined dependent variables. The design allowed for multiple opportunities to demonstrate replication of effect. In addition, inter-observer agreement and social validation were incorporated.

Fidelity of the sensory integration intervention was ensured by using a checklist based on the Fidelity Measure (Parham et al., 2011), which employed a multiple baseline research design that allowed several opportunities for replication, along with administering the Sensory Processing Measure, a standardized measure (Miller Kuhaneck, Henry, & Glennon, 2007).

Well-defined target behaviours were used as dependent variables and inter-observer agreement (IOA) and social validation were applied to decrease the chance of observer and researcher bias and determine the validity of outcomes according to stakeholders

This study targeted 5- to 6-year old children in their first year of schooling, who had little or no prior exposure to occupational therapy, unlike most of the earlier studies that covered a range of ages, from pre-schoolers to adolescents.

In keeping with the aim of seeking useful interventions to improve classroom behaviours of students with autism and intellectual disability, the study was mainly set with daily sessions in the classroom and a weekly session in a school gym. Many of the earlier studies, 12 out of 20, were in a clinical setting.

Thus, this study met most of the recommendations for single subject research (Kratochwill et al., 2010; Logan, Hickman, Harris, & Heriza, 2008), as well as recommendations for research into effectiveness of sensory integration intervention (Leong et al., 2015). Chapter 3 details the method and design of the present study incorporating the above recommendations for rigorous single-case experimental design.

Chapter 3

Method

Introduction

This chapter consists of the following sections: overview of the method, participants, ethical approvals, dependant variables, instruments, single case multiple baseline design, repeated measures design, data collection, data analysis, and summary.

Research design

The present study used a combination of two quantitative methods to investigate the SI intervention:

(a) Single-case, experimental, multiple-baseline design to investigate individual changes in task engagement, student initiated social interactions, and emotional behaviours, in terms of their frequency and cumulative duration during routine days at school.

(b) Repeated measures pre-intervention (T0), post-observation of intervention (T1), and maintenance (T2) design to evaluate changes in sensory processing subsystems and overall sensory processing capacity at a group level, as perceived by the class teachers.

An experimental design was considered the preferred selection, with the multiple-baseline design chosen to provide adequate replication effect with its staggered introduction of the sensory integration intervention at different points over the period of treatment (Kratochwill et al., 2010).

The central research method used in this study is a single-case experimental design (SCED). A multiple baseline approach was used, and involved direct observations of target behaviours: task engagement, student initiated social interactions, and emotional behaviours of participants. It was supplemented by the repeated measures design that is discussed later in this chapter.

Single case experimental designs (SCED) are used regularly for research in the field of special education (Horner et al., 2002; Kennedy, 2004, 2005), especially when the experimentation aims to modify behaviour and study the effect of intervention (Gabler, Duan, Vohra, & Kravitz, 2011; Shadish, 2014; Shadish & Sullivan, 2011). SCEDs are typically used for participant groups that are inherently diverse from each other and effects of any intervention are better studied by using the participants as their own control (Gabler et al., 2011; Kennedy, 2005; Shadish & Sullivan, 2011). The key requirements of a SCED are stability of performance without much variability at baseline followed by ongoing assessments during intervention to track any changes without the need to institute a trend line (Kazdin, 2016).

Designing the single case multiple baseline design

This study used a multiple baseline (phase A) and intervention (phase B) design for 6 participants in 2012, 6 participants in 2013 and 11 participants in 2014. The study examined the effect of a SI intervention on four dependent variables (task engagement, student-initiated social interactions, frequency and cumulative duration of emotional behaviours). This design is commonly recommended when there is more than one target behaviour under investigation within the same individual and subject to the same intervention (Tawney & Gast, 1985), or when there are multiple participants with similar target behaviours participating in the same intervention (Kratochwill et al., 2010; Richards et al., 2013b). The design enables a researcher to predict variability of change in target behaviours based on underlying theoretical principles (Neuman & McCormick, 1995). Multiple baseline SCED designs also provide an opportunity for replication and verification of the predicted change in response to intervention (Richards et al., 2013b). Multiple baseline designs typically involve multiple baselines across behaviours, settings, or, as observed in this study, multiple participants (Kratochwill et al., 2010; Richards et al., 2013b). Multiple baseline SCEDs are effective when the effects of intervention are not reversible (Creswell, 2008; Kazdin, 2016; Kennedy, 2005; Kratochwill et al., 2010; Richards et al., 2013b).

This study conducted five or more baseline observations to establish baseline performance stability, and at least twenty observations during the intervention phase as recommended with a staggered implementation of intervention across participants for each year (Kazdin, 2016; Richards et al., 2013b). The baseline phase and introduction to the SI intervention were staggered across participants in each year cohort. A minimum of five data points was collected during the baseline phase. During the intervention phase a maximum of 20 data points for each participant was recorded. After the intervention was implemented for the first participant, observations were recorded simultaneously with baseline data collected for the remaining participants. This staggered implementation of intervention was implemented across all participants for the three years. These data were collected for three days every week throughout the study, during baseline as well as the intervention phase. In 2012, the staggered implementation of the multiple baselines was somewhat different, as the implementation was between two groups of three students instead of staggered between individual students. The decision of implementing of SI intervention for two groups of three students each was based on student need identified from observations and sensory subscale scores. One group of three children went through the baseline conditions first and then transitioned into the SI intervention. Once stability in the behaviours was evident after participation in the SI intervention in the first group, intervention was implemented for the next group of remaining three students. Despite this, data were collected and analysed individually instead of by group. The staggered intervention was fully implemented for individual participating students for 2013 and 2014.

Direct observations were conducted at the same time every day to rule out any systemic differences in parts of the school day influencing participant behaviour, such as change in the level of alertness or interest. An example of staggered intervention is profiled in Figure 3-1 which shows intervention being implemented in a staggered manner for four communities (Hawkins, Sanson-Fisher, Shakeshaft, D’Este, & Green, 2007).

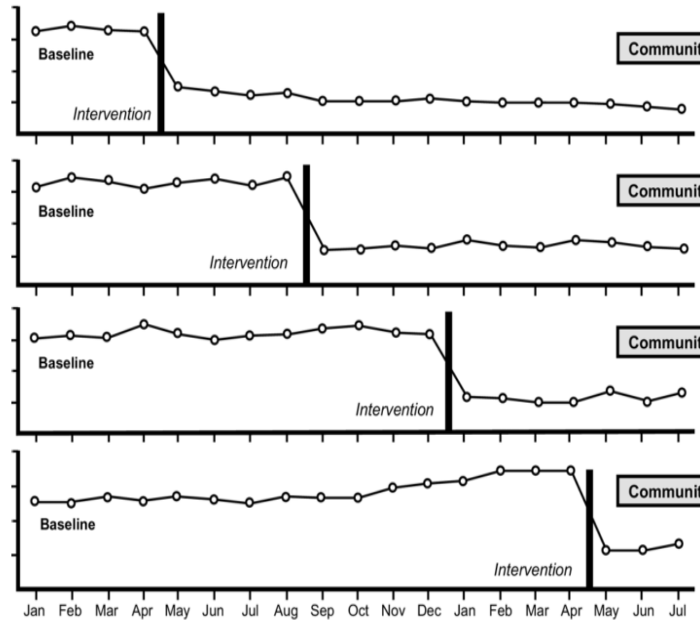


Figure 1. Hypothetical example of a multiple baseline design used to assess behavior change following an intervention in four communities.

Figure 3-1. *Example of a staggered Multiple Baseline SCED* (Hawkins et al., 2007)

This multiple baseline SCED examined the effects of the SI intervention on the dependent variables through direct observations of the participants.

Repeated measures design

Traditionally, an experimental research design recommends measurement of dependent variables multiple times during the course of the experimental process (Creswell, 2002, 2008). A repeated measures design across pre-intervention (T0), post-observation (T1), and maintenance (T2) phases of the study was employed to evaluate changes in sensory subsystems and overall sensory processing ability by yearly cohort (2012, 2013, 2014) as the students participated in the intervention.

The repeated measures design was considered a supplementary research method in this study due to the nature of evaluating children with autism as a group, as children with autism are not homogenous in the presentation of their differences. This design involved examining changes in sensory subsystems and overall sensory processing using the Sensory Processing Measure (SPM) (Miller Kuhaneck et al., 2007) at baseline observations (T0), the conclusion of the intervention-phase (T1), and at 6-12 months after intervention conclusion, also known as the maintenance phase (T2), for participants within each of the three years of this study (2012, 2013, and 2014). The (SPM) (Miller Kuhaneck et al., 2007) was used to collect information regarding perceived changes in sensory processing at subsystem level (social participation, vision, hearing, touch, body awareness, balance and motion, planning and ideas) and at an overall sensory processing level (total sensory systems). The SI intervention was conducted in 2012 and 2013 by classroom teachers under close supervision by OTs, and in 2014 by student OTs under close supervision of OTs in 2014 when direct observations were conducted during the SCED intervention phase. Once twenty observations of intervention were completed for each participant, close monitoring was reduced by ceasing direct observation of the participant and relaxing of staff intervention as the participant continued to engage in activities. As mentioned earlier, staff continued to offer activity visuals to the students at the beginning of each session, monitor for safety, and provide occasional assistance as needed.

Traditionally, such type of intervention has been administered by an OT in a clinical setting. Most prior studies have also been conducted in a clinical setting (see literature review in Chapter 2). This study differed in the manner where the intervention was implemented in a classroom as antecedent to curriculum tasks, to translate the OT knowledge into classroom practice. The SI intervention varied each year in terms of the background and expertise of who implemented it, as described in "Adult Participants" earlier in this chapter.

Participants

The overall number of participants (n = 23) for this study was larger than those reported in previous studies (Chapter 2). However, the within-year and between-year numbers were considered small sample sizes for analyses using tools such as one-way and repeated measures Analysis of Variance (ANOVA) (Bonett, 2002).

There were two groups of participants in this study: students (children with dual diagnoses) and adults comprising of staff members, parents, and occupational therapy professionals.

Student participants

The primary participants were twenty three 4- to 6-year old children, each with a diagnosis of autism and intellectual disability, in their foundation year (first year of formal schooling in Australia) attending a special school in South Australia.

The study took place across three years, with six children participating in 2012, six in 2013, and eleven in 2014. None of the children were repeated across the three years when the study was carried out. The inclusion criteria were a diagnosis of autism characterized by reduced communication ability (absence of functional speech and/or non-verbal communication), high sensory needs, minimal task engagement, and poor social interaction, with additional frequent emotional crises (two to three per day), including challenging behaviours. Information on the children was obtained mainly from their pre-entry assessments, which are routinely assembled to decide placement options (special school, special class, or mainstream class) and are conducted by an educational psychologist following referral by parents and preschool staff. All participants had an additional co-occurring intellectual disability confirmed by an educational psychologist. Table 3-1 provides information about the participants for each year of the study.

Table 3-1. *Participant details (students)*

Year	***Students (n)***	***Gender***		***Age (years and months)***		
		M	***F***	***Minimum***	***Maximum***	***Mean***
2012	*6*	*6*	*-*	*4 years 10 months*	*5 years 3 months*	*5 years 1 month*
2013	*6*	*6*	*-*	*5 years 1 month*	*5 years 8 months*	*5 years 4.5 months*
2014	*11*	*8*	*3*	*4 years 11 months*	*6 years 0 months*	*5 years 4 months*

As evident in Table 3-1, there were more males (*n* = 20) compared to females (*n* = 3) participating in this study. This proportion is roughly in line with the general population, where the male-to-female ratio is reported as between 2:1 and 5:1 (Lai, Lombardo, Auyeung, Chakrabarti, & Baron-Cohen, 2015). The age range of participants was 4.10 years to 5.1 years, with an average age of 5.3 years.

Adult participants

The secondary participant group in this study consisted of staff members at the school and parents as depicted in table 3-2.

Table 3-2. *Participant details (adults)*

Year	**SPM**	**Direct observations**	**IOA**	**Fidelity checklist**	**Social validation**
2012	Teacher (1)	Teacher (1)	TA (1)	Expert OT (1) completed retrospectively	Parent (1)
2013	Teachers (2)	Teachers (2), TA (1)	Researcher	Expert OT (1) completed retrospectively	Parents (2)

2014	Teachers (3)	Teachers (3) TAs (7)	Researcher	Expert OTs (2)	Parents (4)

Note: TA – teacher assistant.
Number in brackets indicate the number of adult participant as described

Staff. Staff included six teachers, seven teaching assistants, two occupational therapists (OT) who were experienced in SI intervention, and four OT students, who were completing a practicum requirement of the fourth (final) year of study. They were involved in administering the Sensory Processing Measure Main Classroom Form (Miller Kuhaneck et al., 2007) as described below. In 2012, one teacher collected the main data and one teaching assistant collected concurrent data for inter-observer reliability. In 2013, two teachers and one teaching assistant collected the main data, with the researcher providing inter-observer reliability. In 2014, three different teachers and seven teaching assistants collected the main data across three separate classrooms, with the researcher collecting data simultaneously for inter-observer reliability.

The researcher and participating teachers underwent some basic training in occupational therapy and SI intervention techniques in 2011 and 2012. One OT provided expert consultation with the class teachers in 2012, and consulted with teachers once a fortnight about participant behaviours and sensory subscales that scored as “some problems” and “definite dysfunction” on the Sensory Processing Measure (Miller Kuhaneck et al., 2007) at baseline. Intervention activities were guided by the OT’s suggestion and implemented by a class teacher. The researcher worked with class teachers and their teaching assistants to describe and score the target behaviours until more than 80% agreement scores were reached and data collection could begin.

In 2013, the consulting OT was able to conduct fortnightly visits and to observe participating students in their classrooms. At baseline, the researcher and class teacher discussed each participant's classroom difficulties and any sensory subscales scores in the "some problems" and "definite dysfunction" categories of the SPM. The SI intervention was implemented by the class teacher and teaching assistants based on these discussions and on OT's observation-based recommendations.

In 2014, there were three participating classrooms with three class teachers and their teaching assistants. The teachers administered the Sensory Processing Measure (Miller Kuhaneck et al., 2007) and collected the main data. The researcher collected data concurrently for inter-observer reliability. There were two OTs who guided and supervised the SI intervention, which was implemented by the fourth year OT students, who also conducted pre-intervention assessments with the participating students. Intervention activities for individual students were planned by the OT students based on the sensory subscale scores of the child and the findings from the baseline assessments. Individual goals were determined by the OT students and the class teachers that would help the child in the classroom for task engagement and manage their emotional behaviours.

It is important to note that the participant cohort of children with autism and ID changed each year and none of the children were repeated during, as the study targeted the implementation to the children in their beginning year of schooling for 2012, 2013 and 2014.

Parents. The other adult participants in the study were randomly selected seven parents, one in 2012, two in 2013 and four in 2014, who viewed the videotapes of their child and completed a social validation questionnaire.

Researcher. The researcher was a teacher employed at the special school, and had conducted a pilot study at the same school in 2011. Hence, the researcher could train other staff for their part in data collection.

Ethical approvals

As a part of regular school practice, the staff collected baseline data on all first-year students with autism and intellectual disability and subject to the SI intervention in 2012 and 2013. The researcher obtained the data retrospectively for analysing the effects of intervention on six students from 2012 and six students from 2013 after receiving ethical approval from the education organisations, permission from the school leadership and informed consent from the parents of the students in the study to obtain (Appendix I, letter of consent for retrospective data). Ethical approval, permission from school leadership, and informed consent from parents were obtained for the collection and analysis of data for all participants in 2014 (Appendix F, letter of consent for Principal of school; Appendix G, letter of consent by parents for social validation and Appendix H, letter of consent by parent to collect data from student participants). Permission to conduct research at a school was also sought from the South Australian Department for Education (Appendix J) and the Flinders University, Social and Behavioural Research Ethics Committee (Appendix K).

Dependent variables

In the multiple-baseline SCED of this study, the primary target behaviours – the dependent variables – were identified as periods of task engagement, frequency of student-initiated social interactions, and frequency and duration of emotional behaviours. Dependent variables for the repeated measures design of this study were the Sensory Processing Measure Classroom subscales scores: balance and motion, body awareness, hearing, planning and ideas, social participation, touch, vision, and the total of all subscales scores (Miller Kuhaneck et al., 2007). The SPM Main Classroom form also collects information about the senses of Taste and Smell, however, these two items were not found to provide valid scores. Data were collected at baseline (T0), post observation (T1), and at maintenance (T2).

Dependent variables for the multiple baseline SCED design

This study aimed to examine the changes during and after exposure to the SI intervention in the following target behaviours for students with autism and intellectual disability.

Task engagement. Task engagement was characterized by behaviours such as attending to an instructor (by looking at or orientating towards the instructor), listening or responding to instruction, looking at a task, touching or handling materials, interacting with the teacher, and working at the task to its completion.

Student-initiated social interaction. Student-initiated social interaction was defined as social behaviours that were initiated by the student, such as looking at a person with intention, approaching another person, touching a person intentionally, holding or tugging someone's hand, and vocalizing or using words directed towards another individual. These behaviours were observed during the absence of sustained social interaction, which are characterized by conversation and shared activities.

Emotional behaviour. Emotional behaviour in this study related to behaviours experienced and exhibited by students, and identified by expression of emotional distress, such as crying, loud or repetitive vocalisations, agitated movements (pacing, hand flapping, rocking, and so forth), self-injurious behaviour, dropping to the ground, and aggressive acts (kicking, head-butting, biting, scratching, spitting, and so forth) towards staff, other students, or property.

Dependent variables for the repeated measures design

Dependent variables for repeated measures design of this study were: balance and motion, body awareness, hearing, planning and ideas, social participation, taste, touch, vision, and the total of all subscales scores (Miller Kuhaneck et al., 2007).

Balance and Motion scale (BAL). This referred to the vestibular sensory system, which enabled an individual to stay upright against gravity, holding one's balance and orientation. In a child, a high score on this scale indicated either excessive vestibular input or poor postural control, along with over- or under-responsivity, and the child would have difficulty in maintaining balance and with physical movements. This could cause the child to experience muscular weakness and tiredness, to make their movements clumsy and awkward, and to display a fear of having their feet off the ground. All of these issues would undermine the child's ability to physically participate in school activities and thereby affect their social and emotional wellbeing.

Body Awareness scale (BOD). This referred to the proprioceptive sensory system. High scores in the items for this scale indicated atypical sensory seeking behaviour and difficulty in processing proprioceptive information. A child with a high score would experience difficulty in judging and controlling the force, direction, and speed of their movement, be rough with objects and people, and would likely seek intense stimulation to joints and muscles. These issues would impact participation in activities that required coordinated movements.

Hearing scale (HEA). This indicated difficulties in auditory processing and over- or under-responsiveness, and can cause sensory-seeking or sensory-avoiding behaviour. Children with high scores on this scale would likely display some of the following: covering their ears, making noise to drown out external sound stimulus, and avoiding noisy areas. Such children would find it difficult to orient on a sound, filter out background noise to focus on instruction, and make sense of a verbal instruction.

Planning and Ideas scale (PLA). This scale referred to praxis, which incorporates ideation (conceptualizing, planning, and organizing of movements) and motor planning (planning and executing motor actions). A child with high scores on this scale would have impacted performance in activities that need flexible thinking and planning, and could manifest as controlling behaviours and rigid, repetitive, and manipulative actions.

Social participation scale (SOC). The social participation scales measured the child’s ability to get along with his or her peers and participate in the classroom activities appropriately. This ability includes comprehending and expressing verbal and non-verbal communication, being flexible in social situations and conflict resolution. Higher scores in this scale indicated the child’s difficulties to function across one or more settings. A child with high scores in this scale would experience difficulty with peer and adult interactions or to transition between lessons.

Taste and Smell items. Taste and smell scores addressed the issue of over- and under-responsiveness, seeking and avoiding behaviours, and perception using these senses. Taste and smell were not recorded as separate scales, but were instead used to calculate the total score.

Touch scale (TOU). A child with high score on the items in this scale would have difficulty in processing tactile information. This would be expressed as avoidance of physical contact or nearness to people; the child may not orient to a touch, or be able to process the intensity and duration of a touch. Such a child would indicate tactile defensiveness resulting in avoidance or on the other hand, be seen to seek tactile feedback, by prolonged engagement with sensory stimuli (for example, deep pressure or heavy touch) that others may find painful.

Vision scale (VIS). The items in the vision scale represented difficulties experienced by the child in visual processing, either over-responsiveness or under-responsiveness to visual stimulation, atypical sensory seeking of visual stimulation, and difficulty with visual perception and ocular-motor function. High scores on this scale indicated dysfunction, either moderate or high. A child with high scores would be distracted and confused in a visually rich environment and would display a difficulty in visually demanding activities, such as reading and attending to information on or copying from a board in a classroom.

Total Sensory Systems scale (TOT). This scale combined scores from the balance and motion, body awareness, hearing, , touch, and vision scales along with taste &

smell items. A high score on the total scale indicated “some problems” or “definite dysfunction” (Sensory Processing Measure) in one or more sensory sub-systems and pointed to over- or under-responsiveness and seeking or avoiding behaviours, which, in turn, signify a general sensory processing dysfunction.

Instruments and data collection

The study used the following instruments: direct observation record, a social validation questionnaire, Sensory Processing Measure (Miller Kuhaneck et al., 2007), which is a standardised instrument, and Fidelity checklist, based on the Fidelity Measure (Parham et al., 2011). These instruments are discussed in this section.

Direct observation record

The researcher developed a record sheet that was trialled during a pilot in 2011 and refined to the requirements for this study (see Appendix A). This sheet recorded the target behaviours using three methods of data collection, (a) whole interval recording, (b) frequency and (c) duration. Task engagement was measured using whole intervenal recording of thirty second periods of task engagement over ten minutes. Frequency of student-initiated social interactions over ten minutes of yard play were measured, and frequency and duration of emotional behaviours over a routine school day were measured using the observation record sheet (Appendix A). These observations were recorded for three days of a school week for 6-7 weeks, i.e. 20 intervention points.

Data collection methods to measure changes in each of these variables are outlined in Table 3-3. The “retrospective data” mentioned in Tables 3-3 and 3-4 for years 2012 and 2013 refer to the data collected by the school as a routine practice and obtained for purpose of this study with ethical permissions from the educational organisations and parents of the participating students.

Table 3-3. *Data Collection for multiple baseline SCED*

Year (style of intervention)	**Sample** (n=)	**Minimum data points** Baseline	**Minimum data points** Intervention	**Maintenance**
2012 *Retrospective data*	*(n=6)*	*5* *(3 weeks or more)*	*20* *(7-8 weeks of intervention)*	*None*
2013 *Retrospective data*	*(n=6)*	*5* *(3 weeks or more)*	*20* *(7-8 weeks of intervention)*	*None*
2014	*(n=11)*	*5* *(3 weeks or more)*	*20* *(7-8 weeks of intervention)*	*None*

The Excel Package of Randomisation Tests (ExPRT v.2.1) was used to analyse data from direct classroom observations (Levin, Evmenova, & Gafurov, 2014). This software was not available to the researcher at the commencement of data collection for this study, therefore intervention start points for successive students was done purposefully for the year 2012 based on student need, and subsequently by random selection decided by participating teachers for the years 2013 and 2014. Ideally, The ExPRT (v.2.1) would have randomised intervention start points for the students, if the researcher had knowledge or access to it at the commencement of the study.

One of the requirements of ExPRT (v.2.1) for the multiple baseline (MB) design was that there should be a staggered implementation of intervention for all participants (Kratochwill & Levin, 2014). This study complied with staggered intervention between individual participants in 2013 and 2014; however, the intervention was managed differently for the six participants in 2012. Due to some intensity of behaviours, the class teacher and the consulting OT felt there was a need to plan the intervention for this cohort in such a way that three of the students received intervention after six predetermined baseline sessions. There was an ethical responsibility to deliver intervention as required to the students made evident by the high incidence of challenging behaviours. However, it was also a limitation for the staggered intervention start points of the multiple baseline design. Stability of target behaviours was observed in all cases before commencing intervention. The other three students began intervention following ten baseline observations as per the intended research design. Though the intervention was delivered to participants in two groups, the observations were recorded and analysed individually for each student.

Data were collected for 30 second periods when the student was engaged with a table task during 10 minutes of task engagement. Students were observed and marked every time they initiated any form of social interaction such as speaking, vocalising, looking at, touching or reaching out to another child or adult during 10 minutes of yard play. The observations for the duration of emotional behaviours were collected by making note of the time when the behaviours started and when they stabilised to the level before the start of the behaviours. The emotional behaviours for each participant were described through careful observation of the start-escalation-stabilisation cycle and by comparing notes with all the staff working with the participants (Kazdin, 1982a).

Sensory processing measure

The group design used in this study required an appropriate standardised measure to identify the target sensory subscales that are necessary for adaptive behaviours **(Brown, 2008; Brown & Dunn, 2010; Brown, Morrison, & Stagnitti, 2010)**. A norm-referenced questionnaire, Sensory Processing Measure (SPM), complemented direct observations by enabling teachers and occupational therapists to tailor the types and intensity of SI intervention activities for each child individually, and to identify changes in sensory scores from pre- to post-observation. The SPM Main Classroom Form (Miller Kuhaneck, 2007) was selected for use in this study to provide norm-referenced scores for the following sensory areas: balance and motion, body awareness, hearing, planning and ideas, social participation, touch, vision, and total sensory systems (see Appendix C, the SPM Main Classroom Form).

While being relatively new as a diagnostic tool, the SPM has been used in other studies where the SPM variables have proven to be strong indicators of autism and of severity of symptoms, especially in the home environment compared to school (Fernández-Andrés, Pastor-Cerezuela, Sanz-Cervera, & Tárraga-Mínguez, 2015; Sanz-Cervera et al., 2015).

Internal consistency estimates for the SPM ranged from 0.75 to 0.95 (median = 0.86), and test-retest reliability estimates ranged from 0.95 to 0.98 (median = 0.97) (Miller Kuhaneck et al., 2007). The normative sample used for standardisation of the SPM consisted of 1051 children aged between 5-12 years, living in the United States, and had no identified developmental disabilities. The scores in each sensory domain were compared for change at baseline before the intervention (T0), after the direct observations concluded (T1) and at maintenance (T2). The maintenance scores provided information on the changes in sensory subscales at 12-months (for 2012 participants) and 6-months (for 2013 and 2014 participants). Data collection for maintenance scores was done after 12 months for the participant group in 2012 due to administrative challenges experienced during scheduling of other activities and staff availability. Scores obtained for social participation were similar to the direct observations on social initiation, while scores for planning and ideas, vision, and hearing may have a link with the direct observations for task engagement.

The SPM Main Classroom Form (Miller Kuhaneck et al., 2007) was administered by the class teachers at three times: baseline (T0), post-observation (T1) which was at the end of twenty intervention data points, and maintenance (T2) which was twelve months after intervention in 2012 and six months after in 2013 and 2014. As for collection of SCED data, the retrospective data for 2012 and 2013 was initially collected as routine school practice.

Table 3-4. *Data collection for repeated measures design*

Year (style of intervention)	***Sample (n=)***	***Baseline Method (when)***	***Intervention Method (when)***	***Maintenance Method (when)***
2012 Retrospective data	*n=6*	*SPM (At Week 0)*	*SPM (After 20 data points)*	*SPM (After 12 months)*
2013 Retrospective data	*n=6*	*SPM (At Week 0)*	*SPM (After 20 data points)*	*SPM (After 6 months)*
2014	*n=11*	*SPM (At Week 0)*	*SPM (After 20 data points)*	*SPM (After 6 months)*

Inter-observer agreement (reliability)

Studies that rely heavily on data obtained through human observations are subject to human error and bias. To minimize this subjectivity and to ensure reliability in the data, inter-observer agreement (IOA) was introduced (Kazdin, 1982a). IOA helps to obtain consistency of observation and also to decide whether the target behaviours or dependent variables are clearly defined (Kazdin, 1982a).

In this study, inter-observer agreement involved another observer (the researcher) recording observations simultaneously with the primary observer (the class teacher), using the same instruments. These instruments are described in their relevant sub-sections. Reliability of the observations was achieved by first discussing the defined behaviours to be observed for task engagement, social interaction, and emotional behaviours and second by practising as a team to consistently observe the same behaviours.

In this study, inter-observer agreement involved another observer (the researcher) recording observations simultaneously with the primary observer (the class teacher) for 2013 and 2014. On a fixed day each week (2013 and 2014), the researcher went to each participant classrooms and carried out independent observations simultaneously with the class teacher, using a separate data-recording sheet to collect data on task engagement and social interactions. However, in 2012, one teacher collected the main data and one teaching assistant collected concurrent data for inter-observer reliability.

It should be noted that simultaneous observation could not be conducted for frequency and duration of emotional behaviours. This is because of the need to record these observations as they occurred throughout the school day, and provision of an independent observer could not be made for an entire school day each week.

Inter-observer agreement observations were conducted for 20% of baseline and intervention sessions for each participant, in agreement with the recommended acceptable standards in SCED research (Kazdin, 1982c; Kennedy, 2004; Kratochwill et al., 2010). Both observers marked their respective observation data sheets when each noted occurrence of the target behaviour. Simultaneous non-observance of behaviour was not counted to avoid inflating the agreement ratio according to research recommendation (Kazdin, 1982c). The number of IOA observations to be conducted (20%) was calculated for each participant depending on when they started intervention, such that students who underwent intervention earlier in the study had fewer IOA observations.

A point-by-point method was used to calculate the agreement ratio for periods of task engagement and student-initiated social interactions because they were discreet behaviours (Kazdin, 1982c). The agreement ratio used the following formula:

Point-by-point agreement = $\frac{A}{A+D} \times 100$

Where, A = agreements for the observed behaviour

D = disagreements for the observed behaviour

The IOA thus provided a measure of reliability for the present study. There were further fidelity and validity measures implemented as discussed later in this chapter.

Fidelity Measure checklist

At the commencement of this study, the researcher did not have access to the ASI® Fidelity Measure (ASIFM) (Parham et al., 2011), nor access to the training for administering it. Hence, the researcher developed a checklist to ensure fidelity of the SI intervention with Ayres' principles of sensory integration® based on the work by Parham et al. (2011) when it was in the process of being finalised (see Appendix D, Fidelity Measure Checklist). The checklist consisted of:

(a) Structural elements – These included:

i. Therapist qualifications, supervision by qualified therapist.

ii. Components of pre-assessment – case history, previous referrals, and student observation.

iii. Physical environment – adequate space for physical activity, flexible arrangement for equipment, availability of hooks for suspended equipment, use of rotational devices, provision of a quiet space, bungee cords, mats/cushions/pillows, equipment adjustable for child's size, monitoring of equipment for safe use, storage of unused equipment, documentation of equipment for safety, variety of equipment.

iv. Communication with parents – negotiated goal setting with parent/teacher/therapist, as well as family and teacher education.

(b) Sensory integration programme process elements – physical safety, sensory opportunities, challenges to postural/ocular/oral/bilateral motor control, challenges for praxis and organization of behaviour, collaboration with the student, providing a just-right challenge, success oriented activities, provision of motivation to play and therapeutic alliance.

During the intervention a conscious effort was made to include the ten key strategies from the Fidelity Checklist (Appendix D) developed to ensure that the therapeutic strategies closely followed Ayres' sensory integration® principles (Parham et al., 2007; Parham et al., 2011). The key strategies which were implemented are:

(a) Arranging the room to entice encouragement – the arrangement of the equipment and the choice of the equipment itself was changed weekly so the students did not lose interest through over exposure.

(b) Ensuring physical safety – staff used the time before and during baseline observations to build rapport and a relationship of trust with the participants. In addition, staff were vigilant during the time that participants were engaged with equipment. To ensure the safety of participants, soft-foam filled mats or gym mats were used to cushion the floor around the equipment.

(c) Presenting sensory opportunities – a variety of equipment with tactile, proprioceptive and vestibular feedback was offered and interchanged to avoid loss of interest of participants.

(d) Attaining and maintaining arousal levels – ensured by manipulating the activities to maintain the participants' attention, engagement and comfort.

(e) Tailoring the activities to present a just-right challenge – staff were alert to increase the level of challenge for the activities once the students became proficient. For example, when the student could walk on the balance board confidently, they were given a ball in a pan to carry across, thereby increasing the level of challenge. Other times, the number of repetitions of an activity would be increased.

(f) Ensuring that activities were successful – managed by presenting and modifying the activities in such a way that the participant experienced success with either the entire activity or a part of it.

(g) Guiding the self-regulatory behaviour – achieved by allowing the students to make their own choice of activities and the sequence in which they attempted the activities, getting their help in setting up the activity and by allowing them enough independence to plan the execution of the activity.

(h) Creating a playful context – by encouraging the students' natural desire to explore and play and by fostering social, emotional, motor or object play.

(i) Collaborating in activity choice – by allowing the student to make their own choice of the activities and their sequence. The staff did not pre-determine the choice or sequence of the activities without student's voice.

(j) Fostering therapeutic partnerships – by developing a relationship of trust, being respectful and being mindful of the physical and emotional safety of the students.

These ten areas align with Ayres' sensory integration® principles in three main domains of modifying the environment to provide maximum sensory inputs to the child, fostering adaptive responses through keeping the challenge at a just-right level, and encouraging the building of a rapport with the child. This last was achieved through creating an element of trust and rapport by ensuring that the children were physically safe and also perceived themselves as safe by addressing structural and procedural elements of the intervention.

Data for the fidelity study were produced when the two OTs completed the Fidelity Measure checklist for each classroom and for the gym, once each year (see Appendix E for 2012, and 2013; see Appendix D for 2014) during the intervention. The researcher provided the OTs with the checklist and verbal instruction to (a) mark the elements along a Likert scale for 2014, and (b) mark the elements retrospectively, if they were present in 2012 and 2013 (Likert, 1932). The two OTs independently marked the checklist following the observation of concurrently occurring intervention sessions delivered by four OT students in their fourth year of the OT degree programme in 2014. The sessions were conducted in different parts of a large gym concurrently as the participating children were withdrawn from their classroom for intervention. During the sessions, each fourth year OT student worked with a child assigned to them on a one-on-one basis to complete the activities. In 2013, the OT observed the classroom staff deliver the intervention activities to each participating child on a fortnightly basis. In 2012, the OT had a consulting role and observed the set up in the classroom and the gym separately. The OTs observed the intervention being delivered in the classroom on random single occasions each year to score the fidelity checklist. Hence, it is acknowledged that the fidelity of intervention was at its maximum in 2014 compared to 2013 or 2012.

Data for the fidelity study were produced by OTs completing the Fidelity Measure checklist. The items on the checklist formed a Likert scale with five points: strongly disagree, disagree, neutral, agree, and strongly agree (Likert, 1932). Items receiving “agree” or “strongly agree” were: therapist qualification (for consulting and supervising), close observation of student space for activity, hooks for equipment, use of rotational devices, safety devices (landing mats, cushions), monitoring of equipment for safety, documentation for safe use, variety of equipment, communication between therapist and teacher, ensuring physical safety of students, sensory opportunities, opportunities for optimal level of alertness, challenges for sensory feedback (postural, ocular, oral, bilateral motor control), challenges (praxis and organization), student collaboration with activity, just-right challenge, success-oriented activities, supporting intrinsic motivation and establishing therapeutic alliance. Pre-assessment (case history and previous referrals) received a “disagree” mark, flexible arrangement of equipment and adjustable equipment for student size received a “neutral” mark, and provision of a quiet space in the gym area and use of bungee cords for most of the suspension equipment received “neutral” or “disagree” marks.

Points on the checklist scale were coded numerically, with 1 for strongly disagree, 2 for disagree, 3 for neutral, 4 for agree, and 5 for strongly agree.

Materials and setting

To set up the intervention, all classes were furnished with a sensory kit containing oral motor tools, tactile fidget tools, lycra body socks, gym balls, hammock and an air mattress. The purpose of this kit was to provide the students with proprioceptive, vestibular, tactile and oral motor stimulus in a structured manner. These materials were made available to the students in their classroom when they felt the need to seek out sensory stimulation as illustrated in Figures 3-2 through 3-12.

Figure 3-2. *Fidget tools*

Figure 3-3. *Oral motor tools*

Figure 3-4. *Nuk Brush (oral motor tools)*

Figure 3-5. *Foam filled mats and cushions*

Figure 3-6. *Peanut shaped gym ball*

Figure 3-7. *Mini trampoline*

Figure 3-8. *Hammock*

Figure 3-9. *Vestibular egg-shaped chair*

Figure 3-10. *Swing*

Figure 3-11. *Scooter board*

Figure 3-12. *Tadpole swing*

The equipment in the gym consisted of suspended ropes, ladders, rings and swings and hammocks. In addition, there were landing mats, squeeze tunnels, balance beam, trampolines, scooter boards, ramps, and various tactile surfaces as observed in Figures 3-13 through 3-17.

Figure 3-13. *Vestibular seat*

Figure 3-14. *Foam pit*

Figure 3-15. *Suspension equipment: hammock, ladder, ropes, rings*

Figure 3-16. *A-frame, balance beam, foam wedges, rings, tunnel, steps*

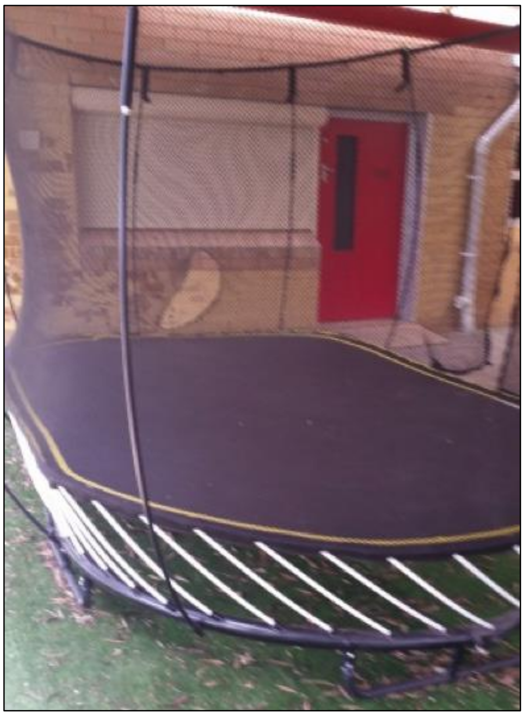


Figure 3-17. *Giant trampoline*

Baseline procedures

The participants were exposed to all the materials in the classroom for the first few days before commencement of direct observations. The participants familiarized themselves with the equipment by looking at it, and/or manipulating it without any adult involvement and without any task demand. On their weekly visit to the gym, they were allowed to familiarize themselves with the equipment laid out, and the participants could freely explore without adult intervention. The only role of staff during the baseline phase was to ensure the safety of the participants around the equipment, by staying within reach or placing landing mats around the equipment. The baseline phase also included administering a SPM (Miller Kuhaneck et al., 2007) and collecting the sensory subscale scores for each participant (see Appendix C), and the SPM dependent variables described above.

Intervention procedures

The intervention was designed to suit individual participants whose needs were indicated from the SPM. In a typical formal therapy session, an OT would administer a detailed battery of assessments to a child before selecting therapy activities. However, this was not possible in a school setting. Instead, the SPM (Miller Kuhaneck et al., 2007) was administered and sensory scores were discussed with the OT, along with relevant observations of any difficult behaviours. Activities were selected based on the OT's suggestion and children chose which activities they would participate in and were allowed to move to another before they crossed the threshold of tolerance or boredom.

In 2012, the intervention was implemented by classroom staff with once-a-fortnight consultation from OTs qualified in the practice of sensory integration. The OT had no classroom interaction, but based their recommendation on observations by the classroom teacher and the sensory subscale scores within the "Some Problems" and "Definite Dysfunction" range on the SPM (Miller Kuhaneck et al., 2007). In 2013, the intervention was again implemented by classroom staff, but was monitored by an OT during fortnightly consultation visits, with the OT observing the participants in the classroom as they continued their normal routine. The OT made recommendations based on these observations and on discussion of the participant's SPM scores. In 2014, implementation of the intervention was primarily conducted by the fourth-year Occupational Therapy students with close supervision by the supervising Occupational Therapists. In 2014, the student participants were individually assessed by the OT students and supervised by the expert OTs. They used these assessments and the SPM scores to develop individual goals and an individualised plan of activities for each student. This plan was communicated to the classroom staff and parents before commencing the intervention.

The intervention was based on Ayres' sensory integration® theory characterized by extensive use of suspension equipment and activities that supported vestibular, proprioceptive, and tactile feedback. A checklist was created by the researcher based on the Fidelity Measure (Parham et al., 2007) to ensure the rigour of the intervention (see Appendix D).

The sensory integration intervention included 40 minutes of structured sensory-stimulating activities in the classroom each day and a one-hour gym session each week. These activities are described in the following sub-sections.

Classroom activities. The teachers asked the students to choose three to four activities by offering them photographs of the equipment. Once the student selected the activities, the teacher would lead them one-on-one through a gross motor trail of the chosen activities. The activities varied from crawling on different surfaces, stable or made dynamic by use of cushions or foam filled landing mats. Sometimes the students walked, crawled, and rolled on inclined and horizontal planes. Other activities involved bouncing on gym balls for some time and doing belly rolls on the ball alternating weight bearing on feet and hands. Also included were bouncing on a trampoline or air mattress while holding the hands of an adult, simultaneously clapping and counting, or while throwing and catching a ball. The students used a variety of swings and hammocks by propelling themselves with their hands and feet, or pulling on a rope held by an adult. Sometimes they propelled themselves on scooter boards navigating around an obstacle course set by the staff, or going back and forth completing an activity such as stacking of blocks or a jigsaw puzzle. Figures 3-2 through 3-12 are indicative of the equipment used for the classroom intervention.

The staff acted as facilitators as they gently guided students into the chosen activity initially, then stepped back to allow the student to continue independently. The students would indicate when they wanted a change and were allowed to move to the next activity according to their choice, which was set up in a circuit. The participants engaged in these activities for approximately 30-40 minutes every day before commencing with their daily school routine. The staff maintained one-on-one supervision and interaction with the participant students throughout the direct observation phase of intervention.

Gym activities. Students participated in similar activities to those of the classroom, but with increased intensity and with additional suspension swings, ladders, ropes, and rings. They would be asked to throw rings at a target while swinging in a hammock and collecting objects scattered under the hammock in a widening circle as they became adept at the task. They would propel themselves with their hands while lying prone in the hammock and pull on a bungee rope held by staff.

They would lie prone on a scooter board, roll down an incline and come to a halt at a foam wedge. A favourite activity was to take a running start and crash into a foam pad. They climbed an A-frame, walked across a balance beam, or carried loose balls in a pan or spoon as they walked across the beam. These activities targeted vestibular activation, visual-motor coordination and improved core strength and balance.

The challenge in all activities was raised at appropriate times, just when the participants became adept at the activity. For instance, when the student could jump on a giant trampoline to a count of ten, they would move on to catch and throw a ball while jumping, or alternating jumps with landing flat on their back on the trampoline, by following verbal instructions by staff.

A strict one-on-one supervision and interaction by staff members with the participants was maintained during the direct observation phase of intervention, which lasted over twenty data points (approximately 7 - 8 weeks). The staff presence ensured a smooth transition of the participants between activities. The school provided extra staff to enable efficient delivery of the intervention to all students. The staff also provided supervision for safety and some assistance to the students in the nature of occasional support and stabilizing of the equipment as they used it. The students indicated their choice of activities for the session using visuals and engaged with them in their own sequence. These activities lasted an hour once per week. Figures 3-13 through 3-17 depict the equipment in the gym.

Maintenance phase

Direct observations were carried out for twenty data points during the intervention (phase B). This encompassed around six weeks, with data collected three days each week. The period after the direct observations were discontinued was termed the "maintenance phase" in this study. At the culmination of direct observations, the intervention continued for the rest of the year as per the school policy, but it was characterized by the fact that while the activities were still offered to individual students, with the same manner of choice, they were no longer attended by staff in exclusive one-on-one manner, as was part of the intervention. The students still selected the activities they wanted, the staff member still offered the photographs at the beginning of the session and supervised the group of students as they progressed through the programme activities. Supervision in this phase was only intended to maintain safety of the students and offer occasional help if it was needed. New goal-directed activities were added only because the child lost interest in some activity, but the addition was not guided by any of the processes used in the intervention. The maintenance of the fidelity measure was therefore not as rigorous as it was during the direct observation phase of intervention.

Maintenance data were not collected for direct observations. Direct observations required a lot of administration to execute, with the arrangement of teacher time and simultaneous researcher time for the inter-observer agreement. This made direct observations difficult to repeat over the maintenance phase due to administrative limitations of the school routines and resources such as staff allocation and change in classroom programmes.

Social validation

Parents of seven participating students were randomly chosen using a blind draw of names. These names were drawn after all observations were concluded in 2014.

The draw resulted in one parent from the 2012 cohort, two parents from 2013, and four parents from 2014.

The students were recorded on video for ten minutes during table-tasks and for ten minutes at yard play, during the same time as the direct observations. Video was collected at the start of baseline observations (T0) and again at the end of observations for the intervention phase (T1).

Each parent was given a DVD with video of his or her child. The DVD had two parts, baseline and intervention, with each part having table-tasks and yard play. In order to remove any bias, the two parts were labelled “T” and “R” and were included in random order on each parent’s DVD.

Parents watched the two parts (T and R), each consisting of table tasks and yard play. While watching table tasks, in each thirty-second interval, parents recorded their questionnaire each time they observed their child engaged on-task. Afterwards they rated their child on a Likert-type scale from “no focus on task” to “prolonged focus on task” and made comments on their child (Likert, 1932). While watching yard play, parents recorded each time their child initiated social interaction in the yard during the ten minutes of observation. Afterwards, they rated the interaction on a Likert-type scale from “no interaction” to “frequent interaction” and made comments on their child. The questionnaire was developed for a pilot in 2011 and was refined according to the needs of this study. The social validation questionnaire is reproduced in Appendix B. Social validation questionnaires (see Appendix B) were completed by parents after watching videos of their children. Results from questionnaires were tabulated, with columns for time intervals of task engagement, parent comments about the nature of their child's task engagement, frequency of social interactions, and parent comments about their child's social behaviour. Time intervals and frequency were scored (by parents) on Likert-type scale of "none", "occasional", "rare", and "frequent" (Likert, 1932).

Data analysis

Two data sets were produced in this study, corresponding to the two experimental designs employed: multiple baseline SCED design and repeated measures design. In addition, data for social validation was produced from parent surveys. Last, data were gathered to analyse the reliability and fidelity of the study. This section describes these data analyses:

(a) Analysing data for multiple baseline SCED design

(b) Analysing data for repeated measures design

(c) Analysing data for social validation – discussed on page 134

(d) Analysing data for the reliability of data from inter-observer agreement – discussed on page 115

(e) Analysing data for the fidelity of the intervention – discussed on page 117

Analysing data for multiple baseline SCED design

The direct observations were analysed by using the Excel Package of Randomizing Tests version 2.1 (ExPRT) (Levin et al., 2014) to obtain statistical significance (*p*- values), decision of significance (S-significant, NS-Not significant) and two effect sizes for intervention (*d*- value and NAP index), along with graphs showing the staggered design to allow for visual analysis. ExPRT (v.2.1) is a set of macro-enabled Microsoft® Excel-based (Microsoft® Office 2010) software for conducting randomization and permutation statistical tests in a wide variety of single-case intervention designs, including AB, ABA, ABAB, and Multiple Baseline designs. ExPRT (v.2.1) is freely available to users (Gafurov & Levin, 2016; Levin, Ferron, & Gafurov, 2016, 2017).

As mentioned above, ExPRT (v. 2.1) provided effect size Cohen's *d* and NAP along with statistical analyses and graphical output. Cohen's *d* effect size was obtained by calculating the difference between the standard deviation of the baseline and intervention phases (Gafurov & Levin, 2016; Kratochwill & Levin, 2014b). However, effect sizes could not be calculated when baseline observations were zero, which occurred in the current data set for student-initiated social interactions across the three years (Gafurov & Levin, 2016; Kratochwill & Levin, 2014a). Thus, the researcher made a decision to use only the NAP from the ExPRT (v.2.1) and R-IRD calculated effect sizes as an additional comparison to analyse the findings for validation. Also, while NAP is considered more robust compared to other non-parametric effect sizes such as, percentage of all non-overlapping data (PAND) and percentage of data exceeding a mean (PEM), R-IRD is still more conservative compared to the NAP (Chen, Hyppa-Martin, Reichle, & Symons, 2016; Parker & Vannest, 2009). Further, the higher sensitivity R-IRD provided the reason why some results from the ExPRT (v.2.1) generated NAP effect sizes were different from the hand-calculated R-IRD effect for some of the students (Parker & Brossart, 2003; Parker & Vannest, 2009; Parker, Vannest, & Brown, 2009).

Randomized intervention start points. ExPRT (v.2.1) was used for entering data and performing calculations, as noted previously. In 2012, it was not used to derive randomized intervention start points for participants, as it was not available to the researcher at the start of the research study. Instead, start points followed recommendations by the class teacher and were based on a high incidence of disruptive behaviours. The intervention start points for the participants in 2013 and 2014 were opportunistic, which were decided by no particular order.

***p* value calculation.** According to Levin et al. (2014) it is possible to request a one-tailed test when A phase (baseline) mean is expected to be more than B phase (intervention) mean, or a two-tailed test when A phase mean is expected to be less than B phase mean. In case a wrong prediction was made and a one-tailed test was requested instead of a two-tailed test, the result would simply appear as “NS, A>B or A<B” to indicate that one should not expect any statistically significant *p*- values in a wrong-sided prediction situation. The same occurred if a two-tailed test was requested instead of a one-tailed test.

Effect size calculation. The ExPRT (v.2.1) provided two effect sizes: effect size *d* and NAP. Calculation for both effect sizes are discussed as follows, however, only NAP was utilised in this study. The effect size *d* is calculated as B phase mean subtracted from A phase mean divided by standard deviation. In certain variables, or in some participant observations, the effect size *d* appeared as a negative value, which simply indicated an average mean decrease between A phase (baseline) and B phase (intervention). (Gafurov & Levin, 2016), explained by the formula as follows:

d = (B phase mean – A phase mean) ÷ A phase SD

ExPRT (v. 2.1) offered two measures for effect size: Cohen's *d* and the proportion of non-overlapping pairs of data points, also known as the NAP index. Effect size *d* is calculated for each case as well as a summary of all cases, which is the simple average of all individual effect sizes for the participant group. The effect size *d* is interpreted as small ($d = 0.2$), medium ($d = 0.5$) and large ($d = 0.8$) (Cohen, 1988, 1992) which did not suit the present study as several zero baseline observations for social interactions rendered the effect size *d* incalculable . A negative *d* value indicated a decrease in the target behaviour (Gafurov & Levin, 2016) and would have been desirable in case of dependent variables such as the frequency and duration of emotional behaviours, but not so desirable for others such as task engagement and social interactions. However, as there were more robust effect sizes available (such as NAP), the results section of this study did not discuss effect size *d*.

NAP calculation. NAP offered the proportion of A phase and B phase that was non-overlapping (Parker & Vannest, 2009). Initial analysis indicated that the proportion of non-overlapping data point observations in baseline phase A and intervention phase B supported the average effect size *d* as reported by ExPRT (v.2.1). A large effect size *d* was corroborated by the proportion of non-overlapping data points that indicated B < A in case of decreasing behaviours and B > A in case of increasing behaviours. In the present study, periods of task engagement and student-initiated social interactions were expected increasing behaviours; while the frequency of emotional behaviours and cumulative duration of emotional behaviours were expected decreasing behaviours. ExPRT (v.2.1) software did not provide an average NAP index as there could be a combination of some B < A and B > A observations within the same group (Gafurov & Levin, 2016). Figure 3-18 illustrates an example of a hand calculation method to calculate effect size NAP (Parker & Vannest, 2009).

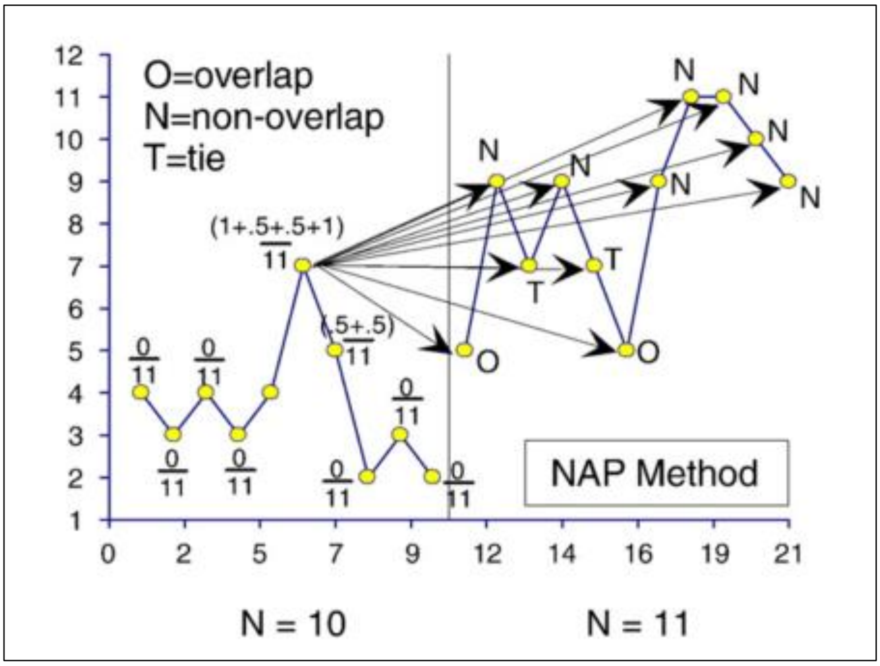


Figure 3-18. *Example to calculate NAP* (Parker & Vannest, 2009, p. 360)

The arrows in Figure 3-18 demonstrate the overlap for only one data point in the 6th data point with value of 7. This method is applied where each data point in phase A is compared with each data point in phase B. This is called the hand calculation method. Hand calculation method was carried out by counting all non-overlapping pairs or by counting all overlapping pairs and subtracting them from total possible number of pairs (Parker & Vannest, 2009). The total possible number of pairs (N) is the product of number of data points in phase A and number of data points in phase B (that is, N = N *phase A* X N *phase B*). NAP effect is considered small (NAP = 0-0.31), medium (N = 0.32-0.84) or large (N = 0.85-1.0) (Parker & Vannest, 2009). The NAP, the second measure of effect size offered by the ExPRT (v.2.1) was selected as a more sensitive effect to report in this study instead of the effect size *d* (Parker & Vannest, 2009).

R-IRD calculation. The researcher used the Robust Improvement Rate Difference (R-IRD) method, in addition to NAP, to calculate effect of the intervention (Parker & Brossart, 2003; Parker & Vannest, 2009; Vannest & Ninci, 2015) to ensure the validity of direct observation data. R-IRD has a long history of application in the medical field and is considered to have greater sensitivity compared to other non-overlap tests. This higher sensitivity of the R-IRD could explain any different results from the NAP and R-IRD effect sizes for some of these students (Parker & Brossart, 2003; Parker & Vannest, 2009; Parker et al., 2009).

R-IRD calculates the effect size in three steps, where step 1 consists of identifying extreme scores in baseline phase and intervention phase. Step 2 involves visually removing these scores so that there are no overlaps, then in step 3 proportion of improvement in baseline and proportion of improvement in intervention phase are subtracted to obtain effect size (Vannest & Ninci, 2015). These steps are explained below. Figure 3-19 contains an example of how to calculate the R- IRD by balancing quadrants.

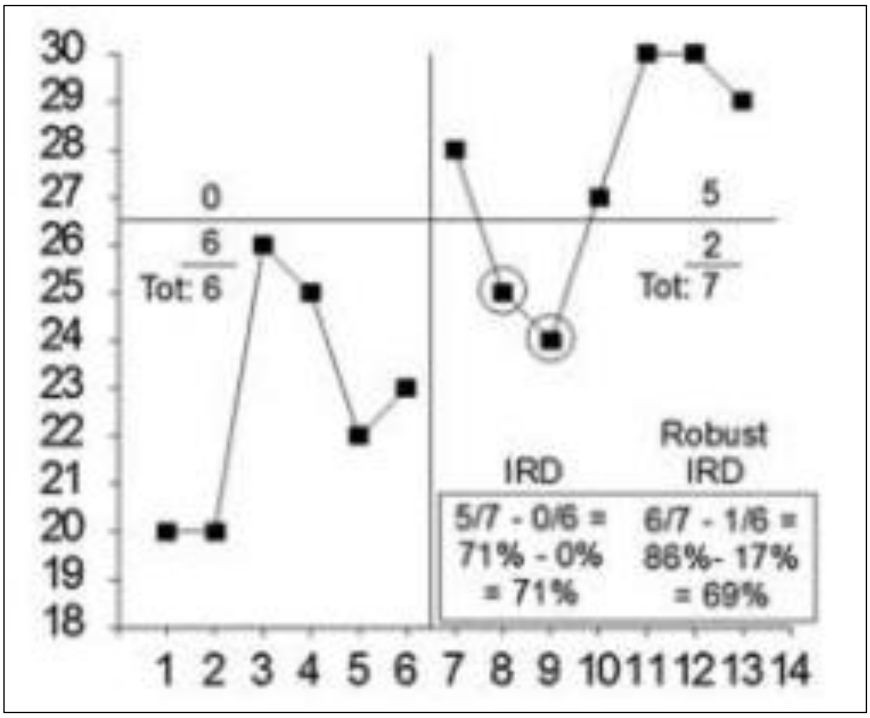


Figure 3-19. *Example of how to calculate R-IRD* (Parker, Vannest, & Davis, 2011, p. 307)

Further elaboration of hand calculation of R-IRD is provided by Barton's explanation of R-IRD (Barton, 2015, pp. 59-60) as follows:

1. Determine the fewest data points to be visually removed to eliminate overlap. To do this, draw a line (called overlap line for this purpose) on the graph.
2. The overlap line lies between the lowest data point in baseline and the highest point in intervention for decreasing behaviours; the overlap line lies between the lowest point in intervention and the highest point in baseline for increasing behaviours. In the present study, task engagement and social interactions were considered increasing behaviours; frequency and duration of emotional behaviours were considered decreasing behaviours.
3. This overlap line now provides the observer with four quadrants, W and Y (baseline phase) and X and Z (intervention phase).
4. Next, balance the quadrants in phase A and phase B using the formulae:

- Y = Phase A = $W \div (W + Y)$
- X = Phase B = X ÷ (X + Z)

5. R-IRD = B - A

R-IRD of 0.5 indicates that 50% of the data points are overlapping between phases, with no improvement. Therefore normally a R-IRD score of more than 0.7 is of interest as it indicates a moderate improvement. The maximum R-IRD value is 1.00 (100% improvement). A negative R-IRD is also possible, and indicates deterioration of behaviour beyond baseline (Parker & Vannest, 2009). R-IRD also provides a confidence interval (CI) at 95%, where a narrow width of CI indicates more precision of effect (Harper, 1999). Thus, R-IRD is considered small or no effect at (R-IRD = 0-0.5), medium at (R-IRD = 0.50-0.70) and large at (R-IRD = 0.70-1.00) (Vannest & Ninci, 2015). A negative effect beyond the baseline would be a desirable outcome for some variables, such as the frequency and duration of emotional behaviours in the present study.

Analysing data for repeated measures design

SPM (Miller Kuhaneck, 2007) scores were analysed for statistical significance by administering the Statistical Package for the Social Sciences version 23 (SPSS v.23), using one-way and repeated-measures analysis of variance (ANOVA) tests. One-way ANOVA tests were administered to check whether there was a significant difference within the SPM scores for participants at baseline for the three years (2012, 2013, and 2014). If there was a significant difference at baseline, it would not be acceptable to compare data from the years, as could not be certain that any observed difference was only due to an effect of intervention. In this study, one-way ANOVA was conducted across all baseline scores for all 23 participants, even though such statistical tests are usually applied to larger sample sizes.

Repeated-measures ANOVA was conducted within each year, rather than across years, for six participations in 2012, six in 2013, and eleven in 2014, since the same variables were measured repeatedly at baseline (T0), post-observation (T1), and maintenance (T2). Traditionally, the ANOVA tests are administered to investigate significant differences between group means and when there is a large sample size (Verma, 2015). A repeated measure ANOVA yields the F-statistic, which is a measure of the effect (variance) between groups. However, in this study, a repeated measures ANOVA was employed to investigate the group differences across the years and also to compare over time (T0, T1, and T2), especially as different people were responsible for the implementation of intervention each year.

In this study, the group means were significantly different on the majority of SPM subscales, which meant they could not be confidently compared across years. The SPM subscale measures for the students could not be investigated together as a group because the instruction was different for each year: by teacher with occasional supervision by OT in 2012, by teacher with regular supervision by OT in 2013, and by student OTs under supervision of expert OTs in 2014. Hence, a decision was made to compare the changes within years based on exposure to teacher, teacher plus OT, and OT (student OTs under supervision) conditions, and then compare the statistical results of within-years and between-years changes with the changes reported by parents on the social validation questionnaire. However, the one-way ANOVA and repeated-measures ANOVA were analysis of a secondary data set, while the ExPRT (v.2.1) analysis of direct observations were the primary findings.

Summary

The present study employed a single-case multiple baseline design to measure changes in periods of task engagement, frequency of student-initiated social interactions, and frequency and duration emotional behaviours. A repeated measures design was also employed to measure changes in scores for the sensory sub-systems from the SPM.

The multiple baseline data were analysed using the ExPRT (v.2.1) software and yielded effect size NAP and staggered graphs for visual analysis. A second effect size R-IRD was calculated to support the NAP. The repeated measures data were analysed for variance (ANOVA) using SPSS (v.23) and produced the F-statistic to measure the effect between groups. Additional data such as IOA to provide reliability, the Fidelity Checklist (Appendix D) provided fidelity of intervention, while analysis of the social validation questionnaire provided a validity measure according to stakeholders (Appendix B). The results from these analyses are discussed in Chapter 4.

Chapter 4

Results

This chapter will discuss the results from analysing the data collected over three years (2012, 2013, and 2014) measuring the effect of a sensory integration intervention on three different groups of young students with a dual diagnosis of autism and intellectual disability in a special school setting.

There were two main data sets: direct observation data, and the sensory subscales scores. The direct observation data were collected on periods of task engagement, frequency of student-initiated social interactions, and frequency and duration of emotional behaviours, during baseline and intervention. The sensory subscales scores were collected using a sensory processing measure (SPM) and represent teacher's perception of changes in sensory processing throughout baseline (T0), post-observation (T1), and maintenance (T2) phases of the study. In addition, results for social validation, reliability and fidelity of the study will be presented. This chapter consists of the following sections:

1. Direct observation data
2. Task engagement
3. Student-initiated social interactions
4. Frequency of emotional behaviours
5. Duration of emotional behaviours
6. Repeated measures data

7. Comparison of direct observation and SPM data

8. Social validation questionnaire data

9. Inter-observer agreement (reliability) data

10. Fidelity measure checklist (fidelity) data

11. Summary

Direct observation data

Direct observation data were collected on periods of task engagement, frequency of student-initiated social interactions, and frequency and duration of emotional behaviours, during baseline and intervention. A summary of data for all of these areas is included in Table 4-1. Data on each area are reported in sections later in this chapter.

Table 4-1 provides a summary of significance denoted by *p*-values across the four dependent variables for the group of participants within each year. Note that in 2012 the intervention was delivered by teachers with occasional OT supervision, in 2013 by teachers with frequent OT supervision, and in 2014 by student OTs under supervision of expert OTs.

Table 4-1. *Summary p-values across years and dependent variables*

Year	***Students***	***Periods of task engagement***	***Frequency of social interactions***	***Frequency of emotional behaviours***	***Duration of emotional behaviours***
2012	*6*	*p = 0.17*	*p = 0.19*	*p = 0.47*	*p = 0.14*
2013	*6*	*p = 0.02**	*p = 0.06*	*p = 0.44*	*p = 0.30*
2014	*11*	*p < 0.001**	*p = 0.01**	*p = 0.01**	*p = 0.06*

Note: Here * denotes statistical significance

No significance was observed across the four dependent variables in 2012 (see Table 4-1) indicated that observed change in target behaviours were due to chance or other factors separate from SI intervention. Results for task engagement indicated statistical significance in 2013 and 2014 indicating that the change in target behaviours may have occurred as a result of the SI intervention. Observed changes in student-initiated social interaction and frequency of emotional behaviours were significant in 2014, but not in 2012 or 2013; again indicating that the changes in 2012 and 2013 may have been due to chance or factors other than SI intervention. There was no statistical significance for the cumulative duration of emotional behaviours across all years. This meant that while some dependent variables indicated a significant difference between baseline and intervention, analysis of individual effect sizes was needed to provide more information about the effect of intervention (Durlak, 2009). The remainder of this section will discuss the effect sizes measured by NAP and R-IRD in addition to visual analysis of the graphical output between years and individually within years.

Data on each area are reported in sections later in this chapter: task engagement, frequency of student-initiated social interactions, and frequency and duration of emotional behaviours.

Task engagement

Task engagement data were gathered by direct observation. Participants were observed across ten-minute periods that were divided into 30-second intervals. At the end of each interval the student was assessed for his or her on-task behaviour.

Overall effects for task engagement

Overall effect sizes for task engagement across the three years (2012, 2013, and 2014) were calculated from the proportion of non-overlapping pair data (NAP index) in baseline (phase A) and intervention (phase B). At a zero chance level, non-overlapping pairs (NAP) scores are interpreted as *small effect* (values in the range 0-0.31), *medium effect* (0.32-0.84), and *large effect* (0.85-1.0) (Parker & Vannest, 2009). NAP values and effects are presented in Table 4-2.

Table 4-2. *Overall NAP scores for task engagement*

		Student										
Year		***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***	***11***
2012	*NAP*	*0.56 B>A *****	*0.69 B>A *****	*-0.57 B<A #*	*0.43 B>A *****	*-0.03 B<A #*	*0.01 B>A **					
2013	*NAP*	*0.25 B>A **	*0.14 B>A **	*0.20 B>A **	*0.17 B>A **	*0.85 B>A ******	*0.65 B>A *****					
2014	*NAP*	*0.59 B>A *****	*0.80 B>A *****	*0.76 B>A *****	*0.36 B>A *****	*0.66 B>A *****	*0.95 B>A ******	*0.98 B>A ******	*0.89 B>A ******	*0.97 B>A ******	*0.87 B>A ******	*0.98 B>A ******

Note: * small effect, ** medium effect, *** large effect, # negative effect

Across the three years, NAP scores indicated medium to large effect for periods of task engagement for 91% (21 out of 23 students) and decrease or negative effect for 9% (2 out of 23 students).

Data were further analysed using R-IRD for individual participant outcomes for each dependent measure, in this case, task engagement (Parker et al., 2009; Vannest & Ninci, 2015; Vannest, Parker, & Gonen, 2011). R-IRD was used to validate the NAP effect sizes due to its greater sensitivity. The R-IRD scores were discussed year by year, and are compared with each year's NAP scores. Overall, R-IRD scores indicated a positive effect for 83% (19 out 23 calculated effect sizes for all three years) for the intervention phase compared to baseline.

Task engagement results for 2012

Figure 4-1 shows periods of task engagement during the implementation of the sensory integration intervention (by classroom teachers) in 2012. The figure shows 30 second periods of task engagement during ten-minutes of tabletop tasks, with the x-axis showing the session number and the y-axis denoting the number of intervals of engagement.

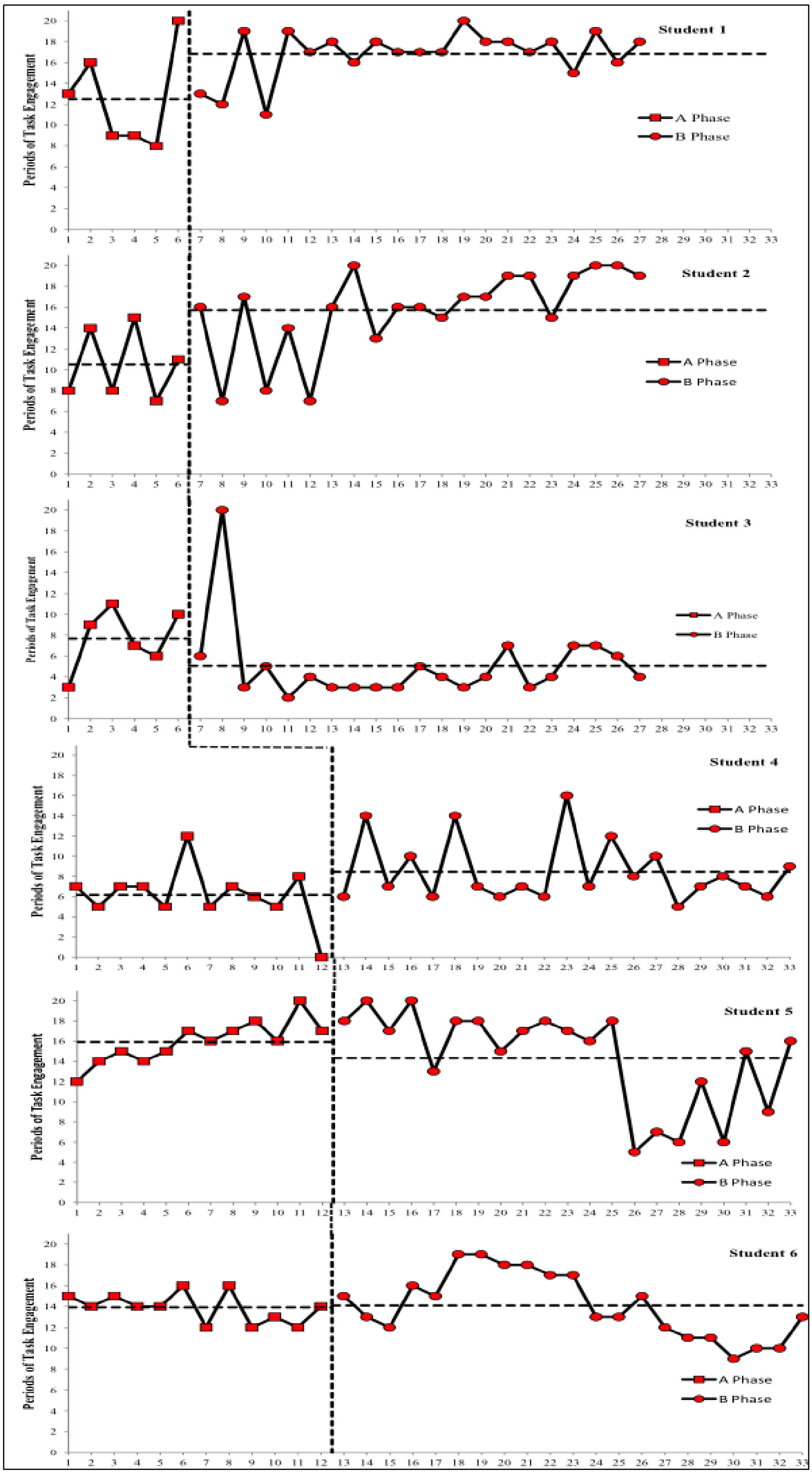


Figure 4-1. *Student task engagement during tabletop tasks, 2012*

Table 4-3 contains NAP and R-IRD scores (at 95% confidence level) for the students in 2012. In the table, NAP scores are interpreted as *small effect* (values in the

range 0-0.31), *medium effect* (0.32-0.84), and *large effect* (0.85-1.0) (Parker & Vannest, 2009). R-IRD scores are interpreted as *small effect* (0-0.50), *medium effect* (0.50-0.70), *large effect* (0.71-0.75), and *very large effect* (0.75-1.00) (Parker & Vannest, 2009).

Table 4-3. *R-IRD and NAP scores for task engagement, 2012*

Student	***Lower limit***	***Upper limit***	***R-IRD***	***Effect***	***NAP***	***Effect***
1	*0.068*	*0.887*	*0.57*	*Medium*	*0.56*	*Medium*
2	*-0.204*	*0.607*	*0.14*	*Small (none)*	*0.69*	*Medium*
3	*-0.286*	*0.235*	*-0.29*	*Negative*	*-0.57*	*Negative*
4	*-0.352*	*0.394*	*0.00*	*No effect*	*0.43*	*Medium*
5	*0.004*	*0.722*	*0.41*	*Small (none)*	*-0.03*	*Negative*
6	*-0.493*	*0.164*	*-0.24*	*Negative*	*0.12*	*Small*

Note: Here "(none)" indicates the result is treated as no effect.

Overall, 50% (3 out of 6 students) indicated some increase, 33% (2 out of 6 students) indicated decrease or negative effect and 16% (1 student) indicated no change. NAP and R-IRD scores from Table 4-3 indicated an agreement between increased task engagement observed for student 1 (NAP = 0.56, R-IRD = 0.57) and student 2 (NAP = 0.69, R-IRD = 0.14), and visual analysis was consistent with this agreement. The NAP and R-IRD agreement of decrease (negative effect) for student 3 (NAP = -0.57, R-IRD = -0.29), again being consistent with visual analysis. For student 4, R-IRD (0.00) indicated no effect of the intervention, whereas NAP (0.43) indicated a medium increase in periods of task engagement during intervention phase over baseline; the visual analysis was consistent with the NAP score indicating medium effect. NAP (-0.03) for student 5 demonstrated a small decrease (i.e., B < A) while R-IRD (0.41) found a small increase in task engagement; visual analysis was consistent with the NAP score indicating a decrease in periods of task engagement.

NAP for student 6 demonstrated a negligible increase interpreted as no effect in task engagement (NAP = 0.12), while R-IRD indicated a negative effect (R-IRD = - 0.24) denoting a small decrease. The visual analysis indicated that the effect of SI intervention was replicated across the two groups of three students, that is two out three students in the first group indicated increased task engagement, while in the second group one showed increase, one showed no change and one showed a decrease, which agreed with the negligible change indicated by the NAP values.

Task engagement results for 2013

Figure 4-2 shows periods of task engagement during the implementation of the sensory integration intervention (by classroom teachers with OT supervision) in 2013.

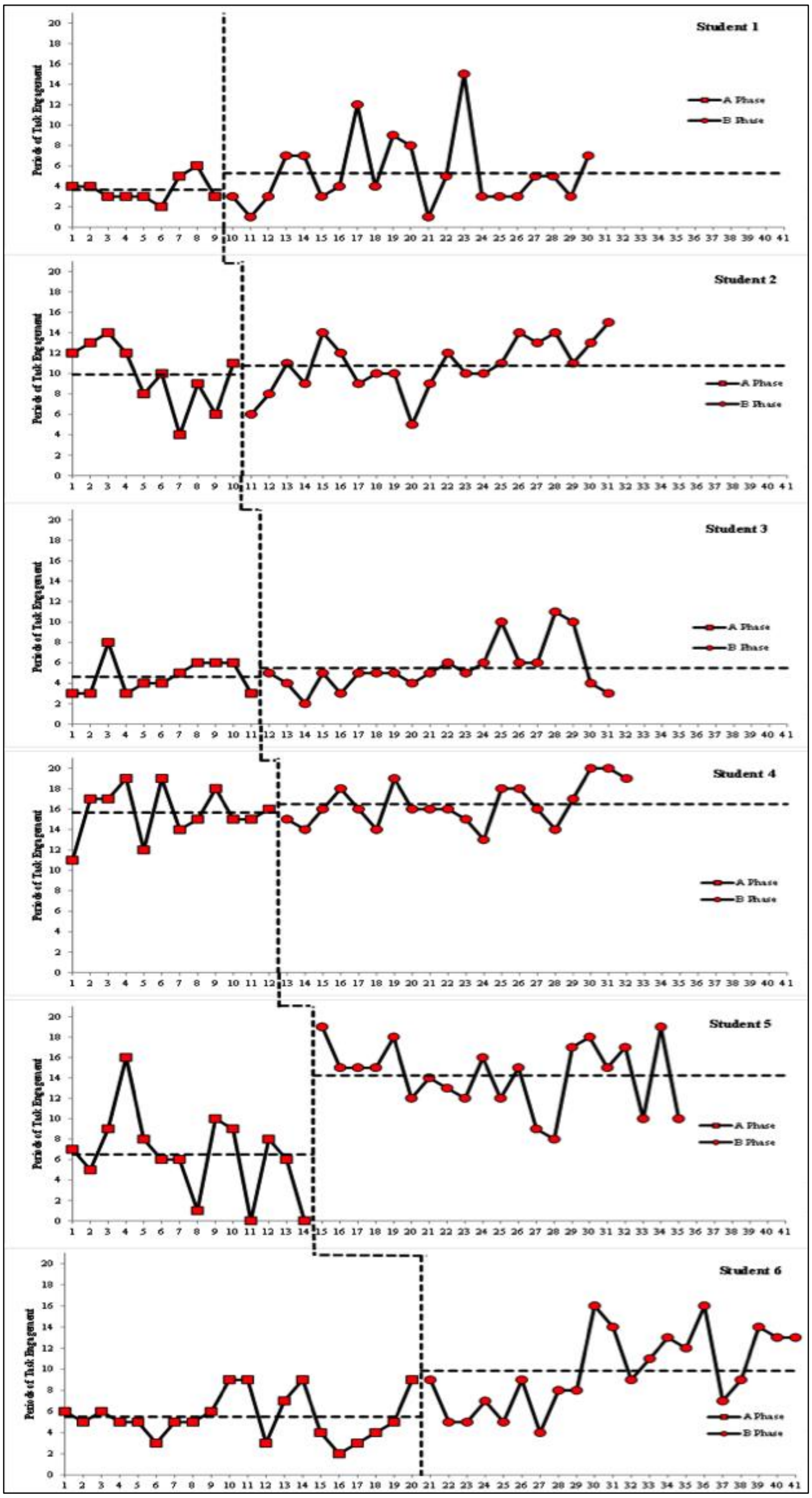


Figure 4-2. *Student task engagement during tabletop tasks, 2013*

Table 4-4 contains NAP and R-IRD scores (at 95% confidence level) for the students in 2013. In the table, NAP scores are interpreted as *small effect* (values in the

range 0-0.31), *medium effect* (0.32-0.84), and *large effect* (0.85-1.0) (Parker & Vannest, 2009). R-IRD scores are interpreted as *small effect* (0-0.50), *medium effect* (0.50-0.70), *large effect* (0.71-0.75), and *very large effect* (0.75-1.00) (Parker & Vannest, 2009).

Table 4-4. *R-IRD and NAP scores for task engagement, 2013*

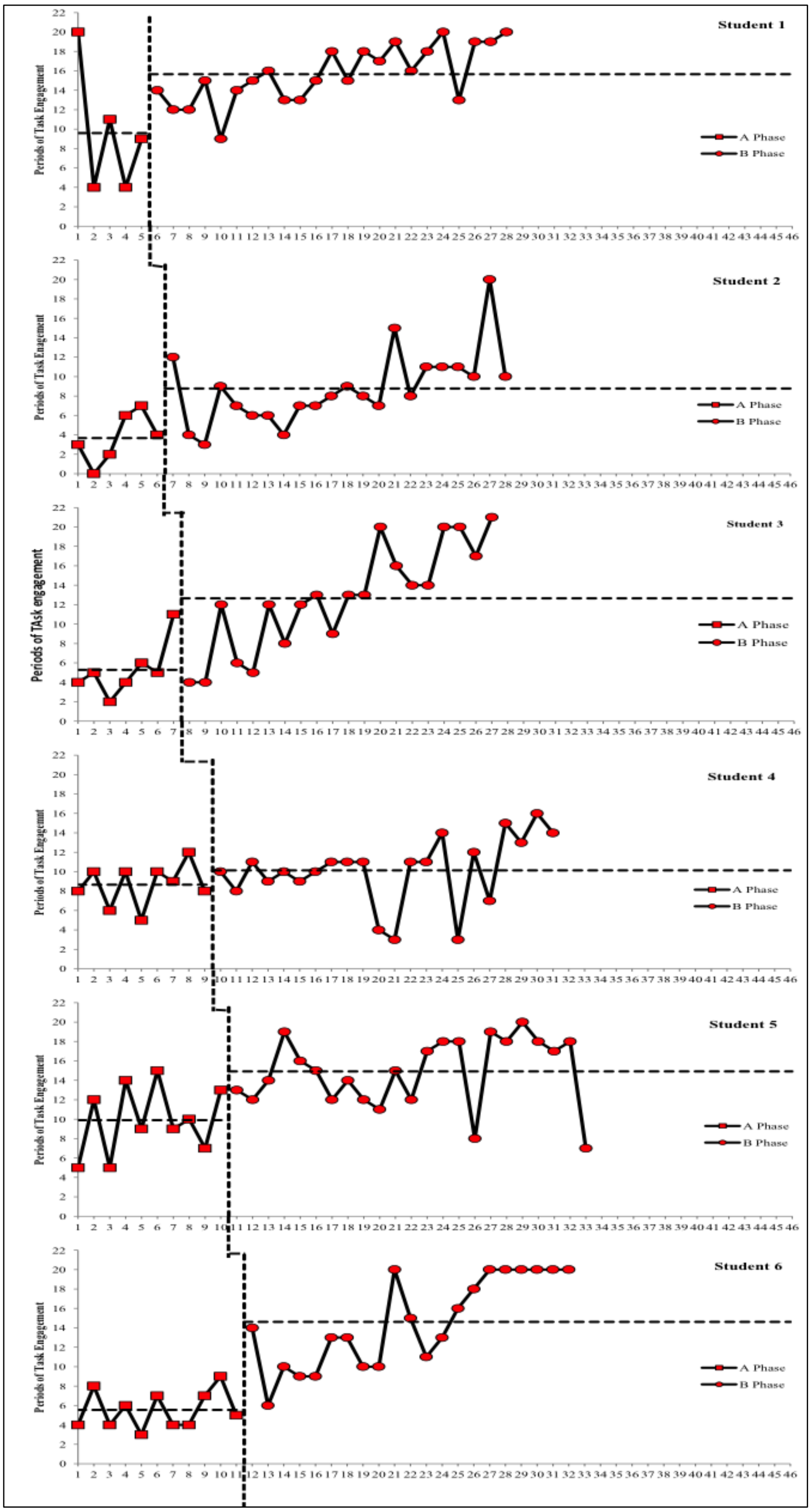
Student	***Lower limit***	***Upper limit***	***R-IRD***	***Effect***	***NAP***	***Effect***
1	*-0.352*	*0.390*	*-0.05*	*Negative*	*0.25*	*Small*
2	*-0.252*	*0.510*	*0.11*	*Small (none)*	*0.14*	*Small*
3	*-0.175*	*0.591*	*0.23*	*Small (none)*	*0.20*	*Small*
4	*-0.193*	*0.562*	*0.20*	*Small (none)*	*0.17*	*Small*
5	*0.325*	*0.905*	*0.70*	*Large*	*0.85*	*Large*
6	*-0.086*	*0.569*	*0.27*	*Small (none)*	*0.65*	*Medium*

Note: Here "(none)" indicates the result is treated as no effect.

According to Table 4-4, R-IRD indicated an overall no effect for 83% students (5 out of 6 students) and a large effect for 17% students (1 out of 6 students). Individual analysis indicated a negative effect indicating a small decrease in task engagement for student 1 during the intervention phase (R-IRD = -0.05) whereas NAP indicated a small increase (0.25). R-IRD in 2013 indicated a small increase interpreted as no effect for student 2 (R-IRD = 0.11, NAP = 0.14), student 3 (R-IRD = 0.23, NAP = 0.20), and student 4 (R-IRD = 0.20, NAP = 0.17). R-IRD for student 5 demonstrated a large increase in task engagement (R-IRD = 0.70) in agreement with the NAP (0.85). R-IRD calculated a small increase interpreted as no effect (R-IRD = 0.27) for student 6 while the NAP calculated a medium increase in task engagement (NAP = 0.65). The overall visual analysis indicated increased task engagement to varied degrees for all students.

Task engagement results for 2014

Figure 4-3 shows periods of task engagement during the implementation of the sensory integration intervention (by student OTs under supervision of expert OTs) in 2014.


Student 1
Student 2
Student 3
Student 4
Student 5
Student 6
A Phase
B Phase
Periods of Task Engagement
Periods of TAsk engagement

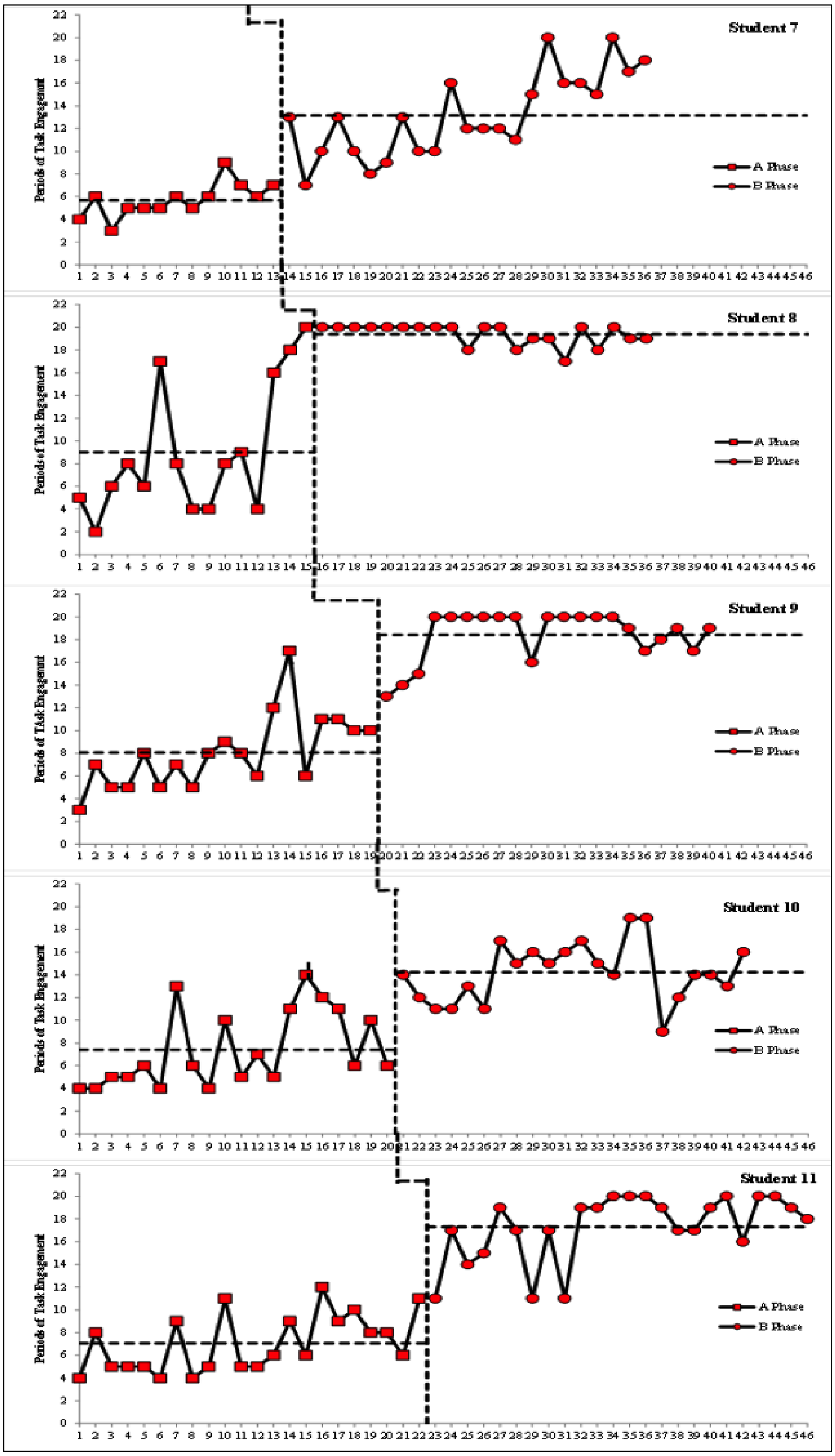


Figure 4-3. *Student task engagement during tabletop tasks, 2014*

Table 4-5 contains NAP and R-IRD scores (at 95% confidence level) for the students in 2014. In the table, NAP scores are interpreted as *small effect* (values in the

range 0-0.31), *medium effect* (0.32-0.84), and *large effect* (0.85-1.0) (Parker & Vannest, 2009). R-IRD scores are interpreted as *small effect* (0-0.50), *medium effect* (0.50-0.70), *large effect* (0.71-0.75), and *very large effect* (0.75-1.00) (Parker & Vannest, 2009).

Table 4-5. *R-IRD and NAP scores for task engagement, 2014*

Student	**Lower limit**	**Upper limit**	**R-IRD**	**Effect**	**NAP**	**Effect**
1	*0.014*	*0.872*	*0.51*	*Medium*	*0.59*	*Medium*
2	*0.077*	*0.889*	*0.58*	*Medium*	*0.80*	*Medium*
3	*0.037*	*0.845*	*0.52*	*Medium*	*0.76*	*Medium*
4	*- 0.173*	*0.625*	*0.22*	*Small (none)*	*0.36*	*Medium*
5	*0.101*	*0.829*	*0.54*	*Medium*	*0.66*	*Medium*
6	*0.095*	*0.802*	*0.51*	*Medium*	*0.95*	*Large*
7	*0.320*	*0.904*	*0.70*	*Large*	*0.98*	*Large*
8	*0.482*	*0.968*	*0.83*	*Very large*	*0.89*	*Large*
9	*0.417*	*0.921*	*0.75*	*Large*	*0.97*	*Large*
10	*0.280*	*0.833*	*0.62*	*Medium*	*0.87*	*Large*
11	*0.538*	*0.955*	*0.83*	*Very large*	*0.98*	*Large*

Note: Here "(none)" indicates the result is treated as no effect.

The effect size calculations provided in Table 4-5 indicated the SI intervention had a medium effect on task engagement for 55% students (6 out of 11students), large effect on 36% (4 out of 11 students) and no effect on 9% (1 out of 11 students). Individual analysis indicated medium effect as follows: student 1 (R-IRD = 0.512, NAP = 0.59), student 2 (R-IRD = 0.58, NAP = 0.80), student 3 (R-IRD = 0.52, NAP =0.76), student 5 (R-IRD = 0.54, NAP = 0.66) and student 6 (R-IRD = 0.51, NAP = 0.95). A large effect was noted for student 7 (R-IRD = 0.70, NAP = 0.98) and student 9 (R-IRD = 0.75, NAP = 0.97). Small NAP effect was demonstrated for student 4 (R-IRD = 0.22, NAP = 0.36). Very large effects were found for student 8 (R-IRD = 0.83, NAP = 0.89) and student 11(R-IRD = 0.83, NAP = 0.98). Student 10 had a medium R-IRD effect (0.62), but a large NAP effect (0.87). These R-IRD findings were consistent with the medium to large effect of SI INTERVENTION on task engagement for all students in 2014, evident by Figure 4-3. Overall visual analysis, too, confirmed the medium to large increase in task engagement for all students.

Student-initiated social interactions

Student-initiated social interaction data were gathered by direct observation. The participants were observed for ten-minute intervals during yard play for three days each week during baseline and intervention periods. Frequency was recorded for each time the student initiated any social interaction with another peer or adult in the yard.

Overall effects for student-initiated social interactions

Overall effect sizes for student-initiated social interactions across the three years (2012, 2013, and 2014) were calculated from the proportion of non-overlapping pair data (NAP index) for baseline (phase A) and intervention (phase B). At a zero chance level, NAP scores are interpreted as *small effect* (values in the range 0-0.31), *medium effect* (0.32-0.84), and *large effect* (0.85-1.0) (Parker & Vannest, 2009). NAP values and effects are presented in Table 4-6.

Table 4-6. *Overall NAP scores for student-initiated social interactions*

		Student										
Year		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
2012	NAP	-0.18 B<A #	0.11 B>A *	0.04 B>A *	0.00 B=A	-0.18 B<A #	0.05 B>A *					
2013	NAP	-0.16 B<A #	0.02 B>A *	-0.12 B<A #	-0.71 B<A #	-0.28 B<A #	0.14 B>A *					
2014	NAP	0.33 B>A **	0.45 B>A **	0.15 B>A *	0.61 B>A **	0.22 B>A *	-0.17 B<A #	-0.22 B<A #	0.74 B>A **	0.73 B>A **	-0.11 B<A #	0.29 B>A *

Note: * small effect, ** medium effect, *** large effect, # negative effect

Table 4-6 indicates that across the three years, the intervention demonstrated a small to medium effect size for 57% of students (13 of the 23 NAP effect sizes calculated based on individual student data) and 43% (10 out of 23 students) indicated a decrease in student-initiated social interactions or negative effect.

Data were further analysed using R-IRD for individual participant outcomes for each dependent measure, in this case, student-initiated social interactions (Parker et al., 2009; Vannest & Ninci, 2015; Vannest et al., 2011). R-IRD was used to validate the NAP effect sizes due to its greater sensitivity. The R-IRD scores were discussed year by year, and were compared with each year's NAP scores. Overall R-IRD scores showed small to medium effects for 26% of students (6 out of 23 participants across 2012, 2013 and 2014) when effect sizes were calculated using the R-IRD.

Student-initiated social interaction results for 2012

Figure 4-4 shows student-initiated social interaction during the implementation of the sensory integration intervention (by classroom teachers) in 2012. The figure shows the number of student-initiated social interactions during ten-minutes of yard play, with the x-axis showing the session number and the y-axis the number of interactions initiated by the student.

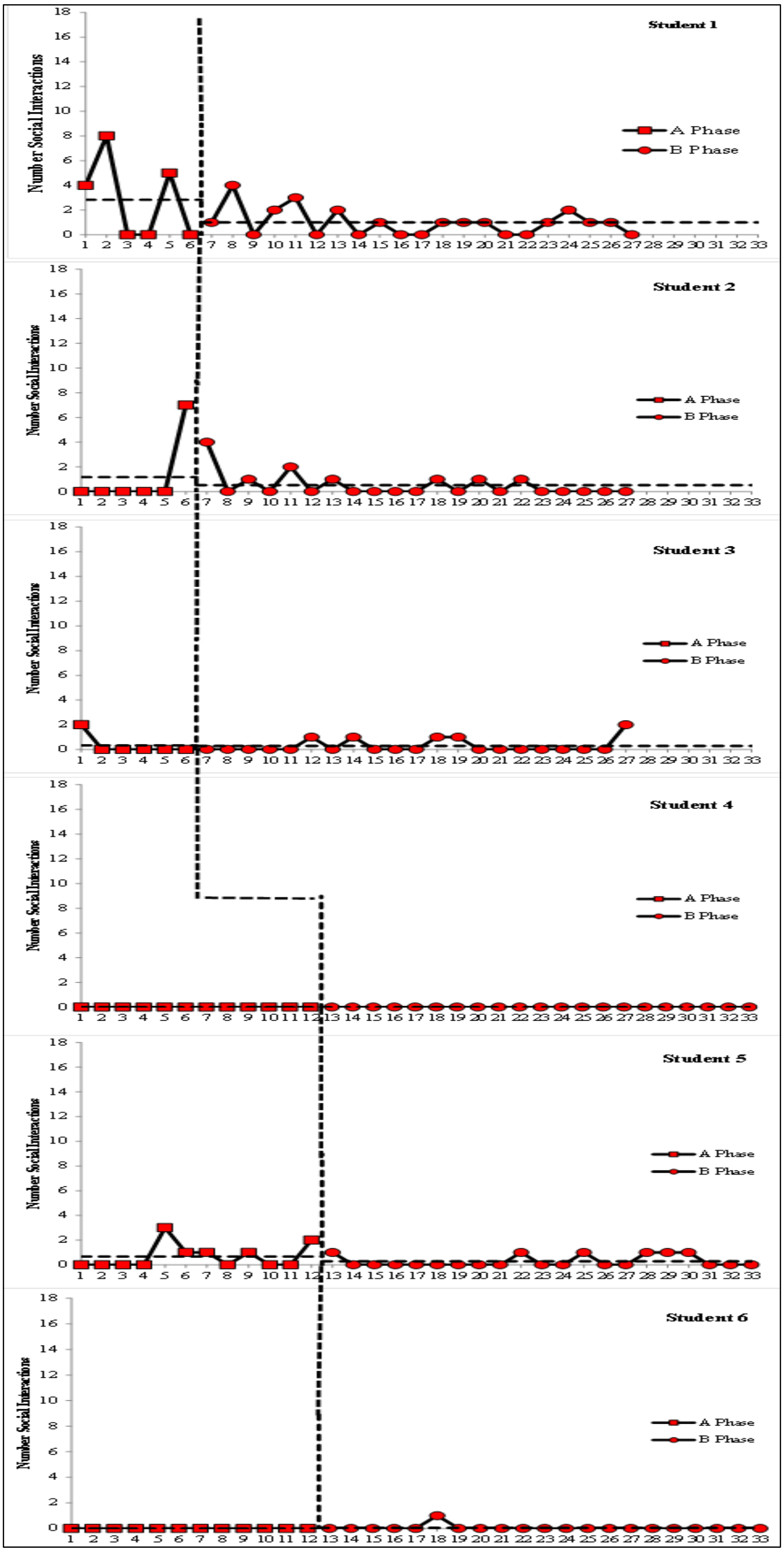


Figure 4-4. *Student-initiated social interaction during yard play, 2012*

Table 4-7 contains NAP and R-IRD scores (at 95% confidence level) for the students in 2012. In the table, NAP scores are interpreted as *small effect* (values in the range 0-0.31), *medium effect* (0.32-0.84), and *large effect* (0.85-1.0) (Parker & Vannest, 2009). R-IRD scores are interpreted as *small effect* (0-0.50), *medium effect* (0.50-0.70), *large effect* (0.71-0.75), and *very large effect* (0.75-1.00) (Parker & Vannest, 2009).

Table 4-7. *R-IRD and NAP scores for student-initiated social interaction, 2012*

Student	***Lower limit***	***Upper limit***	***R-IRD***	***Effect***	***NAP***	***Effect***
1	*-0.286*	*-0.286*	*-1.46*	*Negative*	*-0.18*	*Small*
2	*-0.286*	*-0.286*	*-0.61*	*Negative*	*0.11*	*Small*
3	*-0.286*	*-0.286*	*-0.82*	*Negative*	*0.04*	*Small (none)*
4	*-0.548*	*0.033*	*-0.35*	*Negative*	*0.00*	*No effect*
5	*-0.523*	*0.100*	*-0.31*	*Negative*	*-0.18*	*Negative*
6	*-0.520*	*0.148*	*-0.27*	*Negative*	*0.05*	*Small (none)*

Note: Here "(none)" indicates the result is treated as no effect.

Overall results indicated small or no effect for 83% (5 out of 6 students) and a decrease or negative effect for 17% (1 student).The effect sizes in Table 4-7 indicated a negative R-IRD effect and negligibly small NAP effect size for student-initiated social interactions for all participants in 2012, as follows: student 1 (R-IRD = -1.46, NAP = -0.18), student 2 (R-IRD = -0.61, NAP = 0.11), student 3 (R-IRD = -0.82, NAP = 0.04), student 4 (R-IRD = -0.5, NAP = 0.00), student 5 (R-IRD = -0.31, NAP = -0.18) and student 6 (R-IRD = -0.27, NAP = 0.05). This implied a decrease in student-initiated social interactions during the intervention phase. The R-IRD findings differed from the NAP scores for 2012, in that they indicated a negligible amount of increased social interaction for three out of six students, a small decrease of interactions for two students, and no effect for one student. These R-IRD results were consistent with the visual analysis as observed in Figure 4-4. These results indicate that any changes in student-initiated social iteractions may be attributed to chance or some other variables.

Student-initiated social interaction results for 2013

Figure 4-5 shows student-initiated social interaction during the implementation of the sensory integration intervention (by classroom teachers with OT supervision) in 2013.

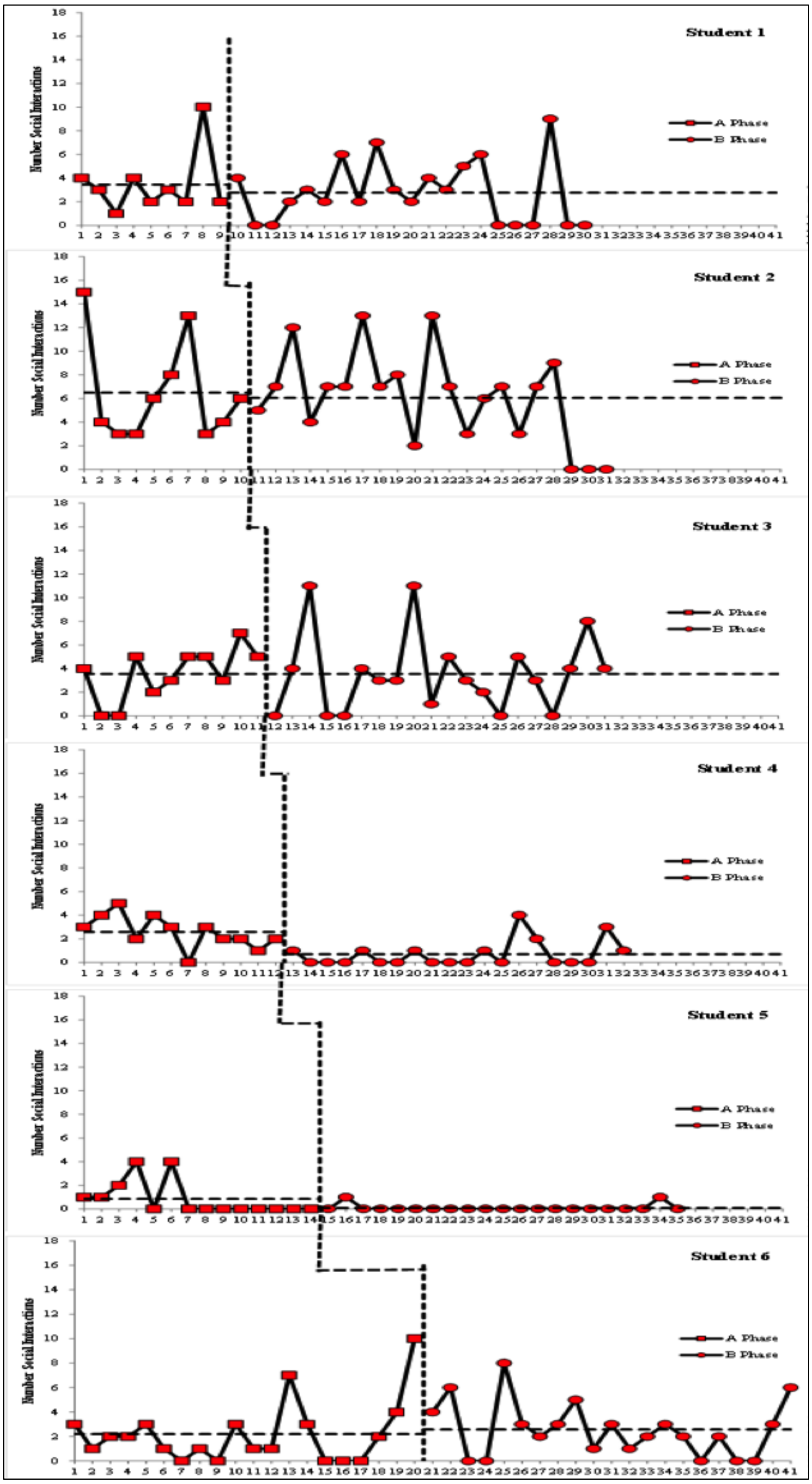


Figure 4-5. *Student-initiated social interaction during yard play, 2013*

Table 4-8 contains NAP and R-IRD scores (at 95% confidence level) for the students in 2013. In the table, NAP scores are interpreted as *small effect* (values in the

range 0-0.31), *medium effect* (0.32-0.84), and *large effect* (0.85-1.0) (Parker & Vannest, 2009). R-IRD scores are interpreted as *small effect* (0-0.50), *medium effect* (0.50-0.70), *large effect* (0.71-0.75), and *very large effect* (0.75-1.00) (Parker & Vannest, 2009).

Table 4-8. *R-IRD and NAP scores for student-initiated social interaction, 2013*

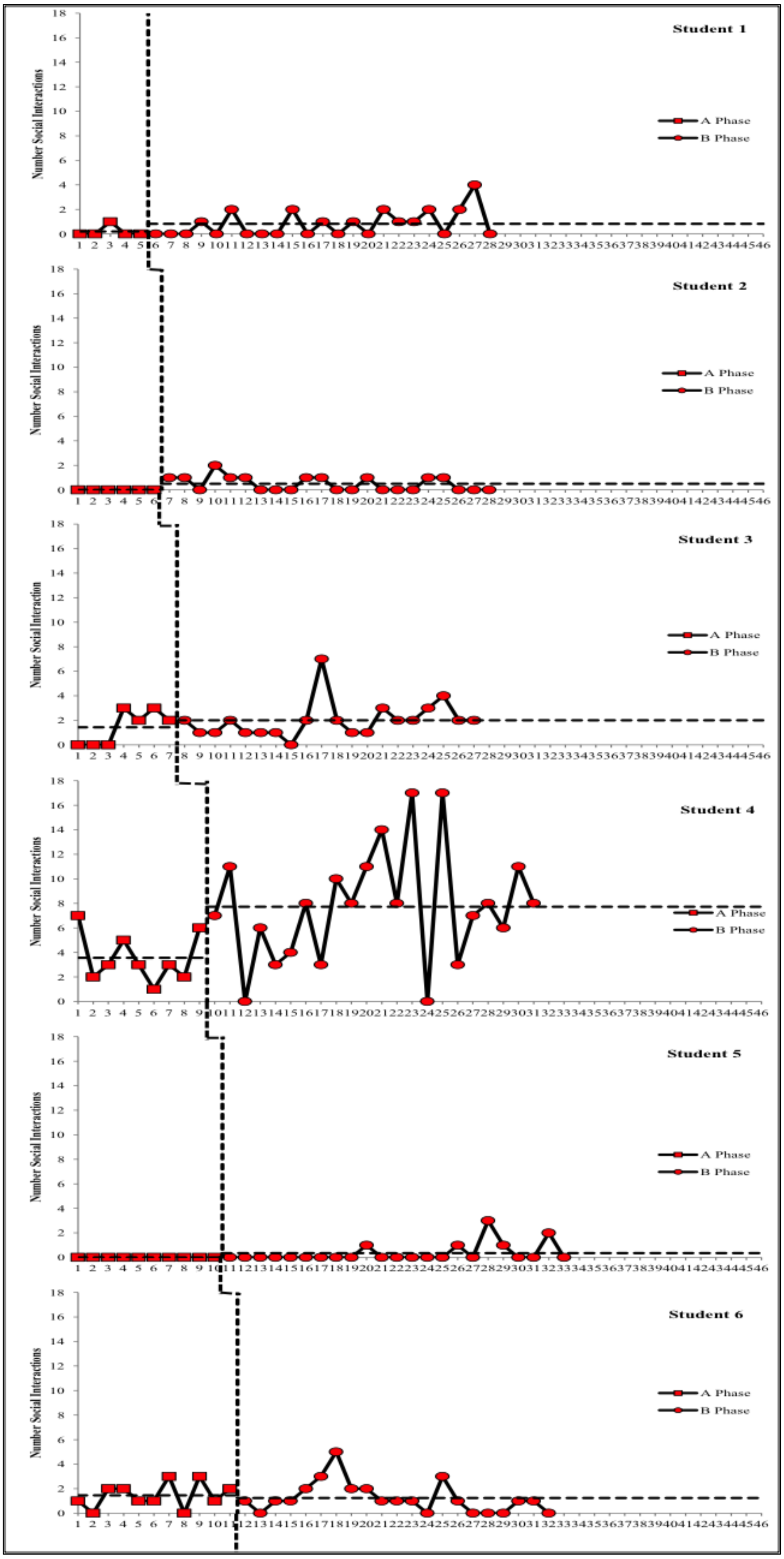
Student	***Lower limit***	***Upper limit***	***R-IRD***	***Effect***	***NAP***	***Effect***
1	*-0.429*	*0.097*	*-0.35*	*Negative*	*-0.16*	*Negative*
2	*-0.252*	*0.510*	*0.11*	*Small (none)*	*0.02*	*Small (none)*
3	*-0.465*	*0.225*	*-0.20*	*Negative*	*-0.12*	*Negative*
4	*-0.600*	*-0.210*	*-0.60*	*Negative*	*-0.71*	*Negative*
5	*-0.423*	*-0.039*	*-0.43*	*Negative*	*-0.28*	*Negative*
6	*-0.271*	*0.402*	*0.07*	*Small (none)*	*0.14*	*Small*

Note: Here “(none)” indicates the result is treated as no effect.

Overall results indicated small or no effect for 33% (2 out of 6 students) and a decrease or negative effect for 67% (4 out of 6 students). Effect sizes from Table 4-8 indicated a decrease in student-initiated social interactions for student 1 (R-IRD = -0.35, NAP = -0.16), student 3 (R-IRD = -0.20, NAP = -0.12), student 4 (R-IRD = -0.60, NAP = -0.71) and student 5 (R-IRD = -0.43, NAP = -0.28), with a negligible increase for student 2 (R-IRD = 0.11, NAP = 0.02) and student 6 (R-IRD = 0.07, NAP = 0.14), interpreted as no effect. These results were consistent with visual analysis as observed in Figure 4-5 signifying that the change could not be attributed to the SI intervention in the case of for students, and that there may be other factors influencing the small effect for two students.

Student-initiated social interaction results for 2014

Figure 4-6 shows student-initiated social interaction during the implementation of the sensory integration intervention (by student OTs) in 2014.


Student 1
Student 2
Student 3
Student 4
Student 5
Student 6
A Phase
B Phase
Number Social Interactions
Number Social Interaction

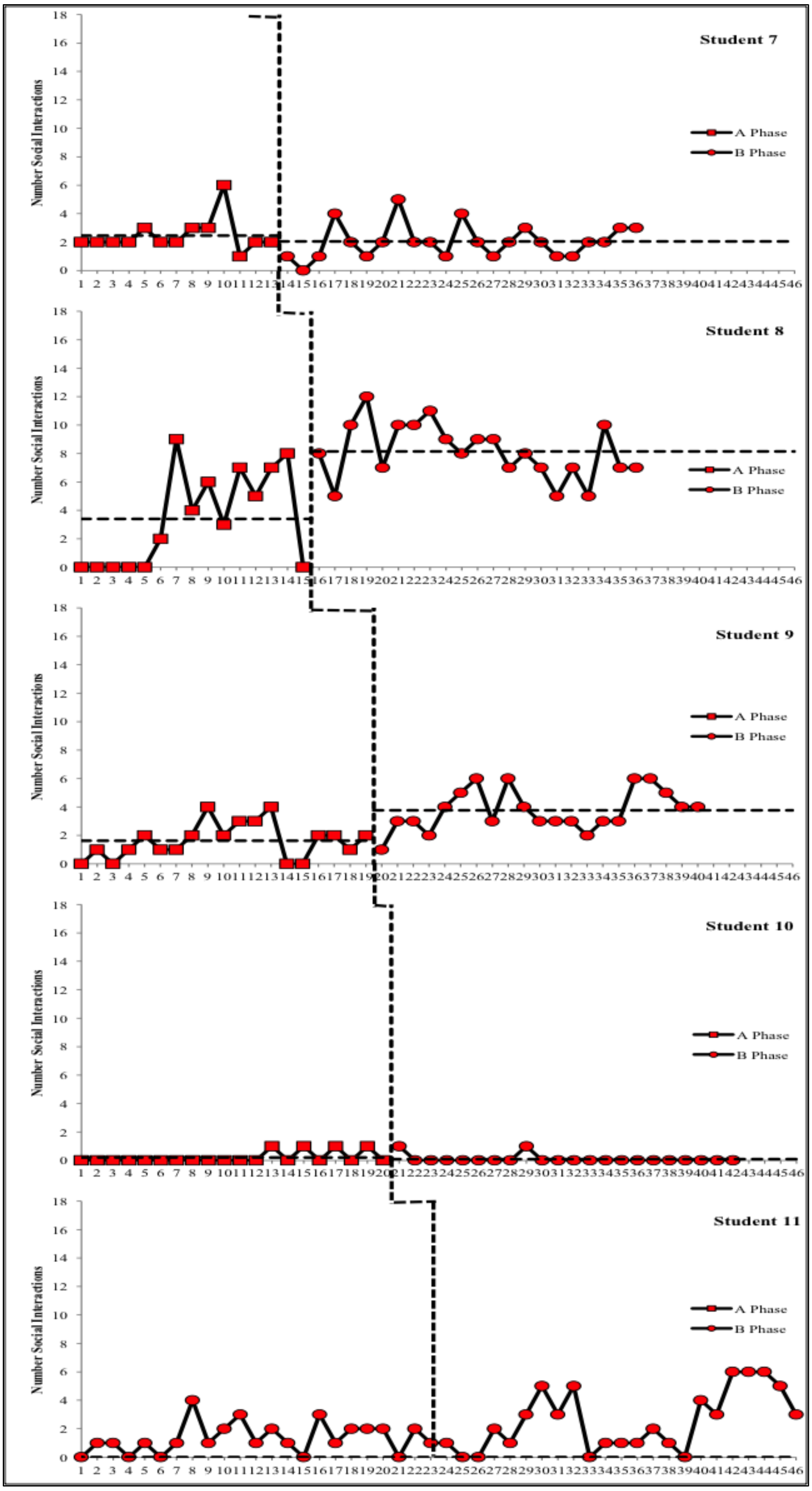


Figure 4-6. *Student-initiated social interaction during yard play, 2014*

Table 4-9 contains NAP and R-IRD scores (at 95% confidence level) for the students in 2014. In the table, NAP scores are interpreted as *small effect* (values in the range 0-0.31), *medium effect* (0.32-0.84), and *large effect* (0.85-1.0) (Parker & Vannest, 2009). R-IRD scores are interpreted as *small effect* (0-0.50), *medium effect* (0.50-0.70), *large effect* (0.71-0.75), and *very large effect* (0.75-1.00) (Parker & Vannest, 2009).

Table 4-9. *R-IRD and NAP scores for student-initiated social interaction, 2014*

Student	***Lower limit***	***Upper limit***	***R-IRD***	***Effect***	***NAP***	***Effect***
1	*-0.067*	*-0.367*	*0.01*	*Small (none)*	*0.33*	*Small*
2	*-0.273*	*0.244*	*-0.27*	*Negative*	*0.45*	*Small*
3	*-0.340*	*0.333*	*-0.16*	*Negative*	*0.15*	*Small*
4	*-0.048*	*0.720*	*0.37*	*Small (none)*	*0.61*	*Medium*
5	*-0.435*	*-0.115*	*-0.51*	*Negative*	*0.22*	*Small*
6	*-0.516*	*0.033*	*-0.39*	*Negative*	*-0.17*	*Negative*
7	*-0.494*	*0.125*	*-0.26*	*Negative*	*-0.22*	*Negative*
8	*0.161*	*0.799*	*0.54*	*Medium*	*0.74*	*Medium*
9	*0.090*	*0.716*	*0.45*	*Small (none)*	*0.73*	*Medium*
10	*-0.460*	*0.199*	*-0.15*	*Negative*	*-0.11*	*Negative*
11	*-0.155*	*0.472*	*0.17*	*Small (none)*	*0.29*	*Small*

Note: Here “(none)” indicates the result is treated as no effect.

Overall results indicate a small or no change for 36% (4 out of 11 students) and a decrease or negative effect for 64% (7 out of 11 students). According to Table 4-9, the individual effect sizes indicated a small increase for student 1 (R-IRD = 0.10, NAP =0.33) and student 11 (R-IRD = 0.17, NAP = 0.29). A small R-IRD effect with a medium NAP effect was observed for student 4 (R-IRD = 0.37, NAP = 0.61) and student 9 (R-IRD = 0.45, NAP = 0.73). Medium effect was observed for student 8 (R-IRD = 0.54, NAP = 0.74). R-IRD and NAP effect were in agreement for decrease of student initiated social interactions in case of student 6 (R-IRD = -0.39, NAP = -0.17), student 7 (R-IRD = -0.26, NAP = -0.22) and student 10 (R-IRD = -0.15, NAP = -

0.11). Additionally, the NAP indices indicated improvement in social interactions during the intervention phase for student 2, student 3, and student 5, which was consistent with visual analysis as observed in Figure 4-6; whereas, R-IRD scores indicated a decrease in social interactions for these students. This difference may be explained by the higher sensitivity of the R-IRD (Parker & Brossart, 2003; Parker & Vannest, 2009; Parker et al., 2009). Overall visual analysis indicated increased social interactions to varied degrees for four students and no change or some decrease for seven students.

Frequency of emotional behaviours

Frequency of emotional behaviour data were gathered by direct observation. Data were collected by counting the number of emotional behaviours displayed by the participants in a routine day at school for three days each week (during the baseline and intervention phases).

Overall effects for frequency of emotional behaviours

Overall effect sizes for frequency of emotional behaviours across the three years (2012, 2013, and 2014) were calculated from the proportion of non-overlapping pair data (NAP index) for baseline (phase A) and intervention (phase B). At a zero chance level, NAP scores are interpreted as *small effect* (values in the range 0-0.31), *medium effect* (0.32-0.84), and *large effect* (0.85-1.0) (Parker & Vannest, 2009). NAP values and effects are presented in Table 4-10.

A lower mean during the intervention phase (in the table, B < A) was considered a desirable outcome for the frequency of emotional behaviours, as this means those behaviours were less frequent during the intervention phase then pre-intervention. The desired B < A result was depicted as negative (#) through the analysis.

Table 4-10. *Overall NAP scores for frequency of emotional behaviours*

		Student										
Year		***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***	***11***
2012	*NAP*	*0.07 B>A **	*0.33 B>A ***	*0.42 B>A ***	*0.36 B<A #*	*0.74 B<A #*	*0.94 B<A #*					
2013	*NAP*	*0.24 B>A **	*0.10 B>A **	*0.02 B<A #*	*0.14 B<A #*	*0.93 B<A #*	*0.09 B>A **					
2014	*NAP*	*0.34 B<A #*	*0.73 B<A #*	*0.01 B<A #*	*0.71 B<A #*	*0.34 B<A #*	*0.14 B<A #*	*0.23 B<A #*	*0.40 B<A #*	*0.05 B<A #*	*0.09 B>A **	*0.35 B>A ***

Note: * small effect, ** medium effect, *** large effect where B>A, # negative effect B < A

Table 4-10 indicated that across the three years, small to large effect sizes in NAP scores pointing to a decrease of emotional behaviours as suggested by lower intervention mean scores (i.e., B < A) were identified for 70% (16 of the 23 effect sizes across 2012, 2013 and 2014 calculated based on individual data) and small increase for 30% (calculated effect sizes for 7 out of 23 students) of pre- to post-intervention data on the measures of frequency of emotional behaviours.

Data were further analysed using R-IRD for individual participant outcomes for each dependent measure, in this case, frequency of emotional behaviours (Parker et al., 2009; Vannest & Ninci, 2015; Vannest et al., 2011). R-IRD was used to validate the NAP effect sizes due to its greater sensitivity. The R-IRD scores were discussed year by year, and were compared with each year's NAP scores. Overall R-IRD scores indicated 86.96 % (calculated effect sizes for 20 participants out of 23 across 2012, 2013 and 2014) decrease in the frequency of emotional behaviours during the intervention phase.

Frequency of emotional behaviours for 2012

Figure 4-7 shows the frequency of emotional behaviours during the implementation of the sensory integration intervention (by classroom teachers) in 2012. The figure shows the frequency of emotional behaviours during a routine day, with the x-axis showing the session number and the y-axis the frequency of emotional behaviours for the student.

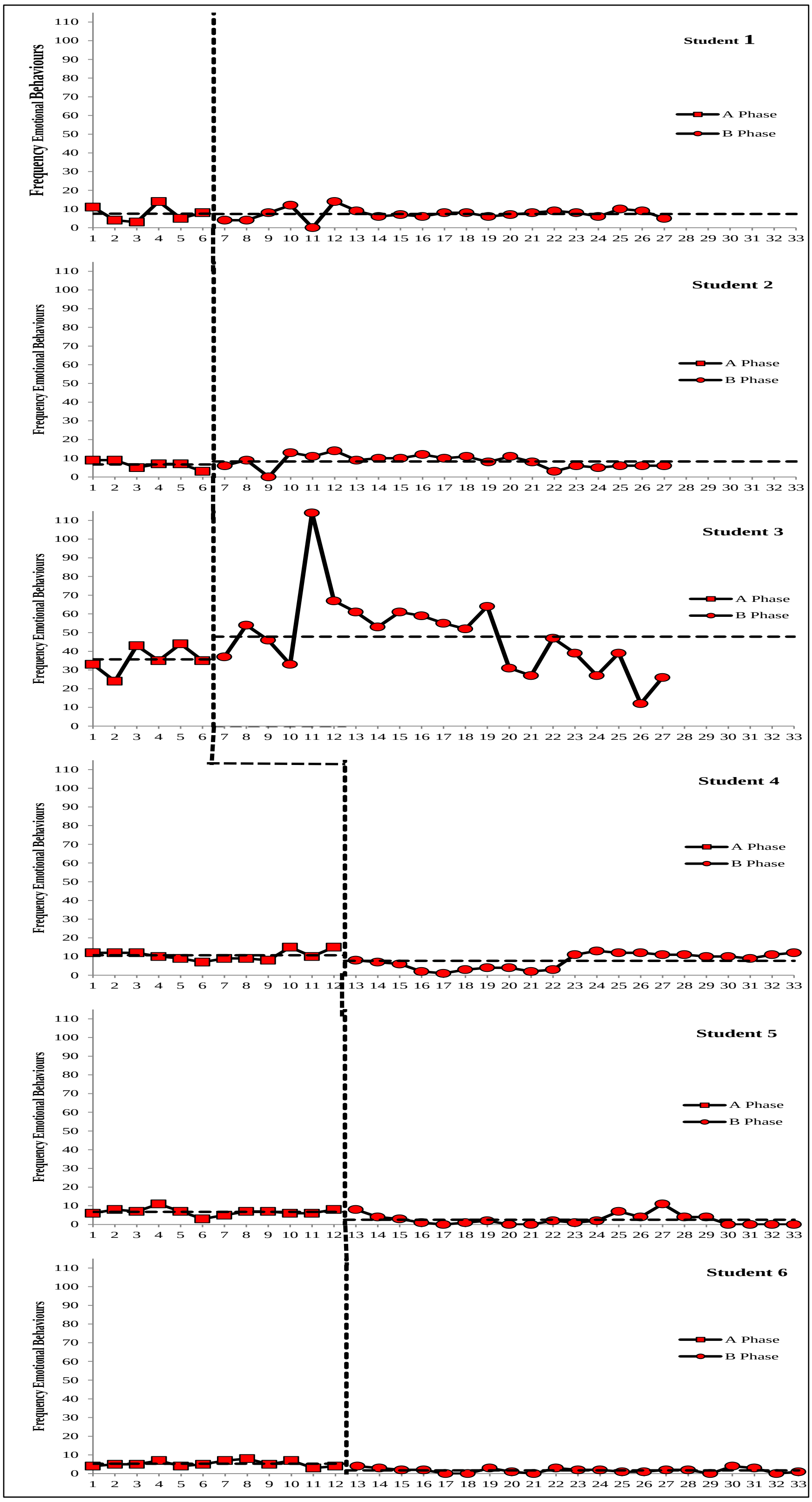


Figure 4-7. *Frequency of emotional behaviours in a routine school day, 2012*

Table 4-11 contains NAP and R-IRD scores (at 95% confidence level) for the students in 2012. In the table, NAP scores are interpreted as *small effect* (values in the

range 0-0.31), *medium effect* (0.32-0.84), and *large effect* (0.85-1.0) (Parker & Vannest, 2009). R-IRD scores are interpreted as *small effect* (0-0.50), *medium effect* (0.50-0.70), *large effect* (0.71-0.75), and *very large effect* (0.75-1.00) (Parker & Vannest, 2009).

Table 4-11. *R-IRD and NAP scores for frequency of emotional behaviours, 2012*

Student	***Lower limit***	***Upper limit***	***R-IRD***	***Effect***	***NAP***	***Effect***
1	*-0.286*	*0.339*	*-0.18*	*Negative*	*0.07*	*Small*
2	*-0.504*	*0.181*	*-0.22*	*Negative*	*0.33*	*Small*
3	*-0.286*	*-0.286*	*-1.14*	*Negative*	*0.42*	*Small*
4	*-0.352*	*0.394*	*0.00*	*No effect*	*0.36*	*Small*
5	*0.118*	*0.810*	*0.53*	*Medium*	*0.74*	*Medium*
6	*0.418*	*0.964*	*0.80*	*Very large*	*0.94*	*Large*

Overall results indicated negative effect signifying a medium to large decrease in frequency of emotional behaviours for 33% (calculated effect sizes for 2 out of 6 students), a small increase for 50% (calculated effect sizes for 3 out of 6 students), no effect for 17% (calculated effect size for one student). The calculated effect size for student 1 (R-IRD = -0.18), student 2 (R-IRD = -0.22) and student 3 (R-IRD = -1.14) indicated a negative effect due to a small increase in the frequency of emotional behaviours as illustrated by Table 4-11 and figure 4-7. The NAP also indicated a small increase in the frequency of behaviours for student 1, student 2 and student 3. The R-IRD scores for student 4 (R-IRD = 0) indicated no effect of intervention on the frequency of emotional behaviours though the NAP indicated a small increase; whereas, effect values for student 5 (R-IRD = 0.53) and student 6 (R-IRD = 0.80) agreed with the NAP scores indicating medium and large improvement by decreasing the frequency of emotional behaviours. Overall visual analysis supported the NAP and R-IRD results indicating decrease for two students, increase for three students and no effect for one student.

Frequency of emotional behaviours for 2013

Figure 4-8 shows the frequency of emotional behaviours during the implementation of the sensory integration intervention (by classroom teachers with OT supervision) in 2013.

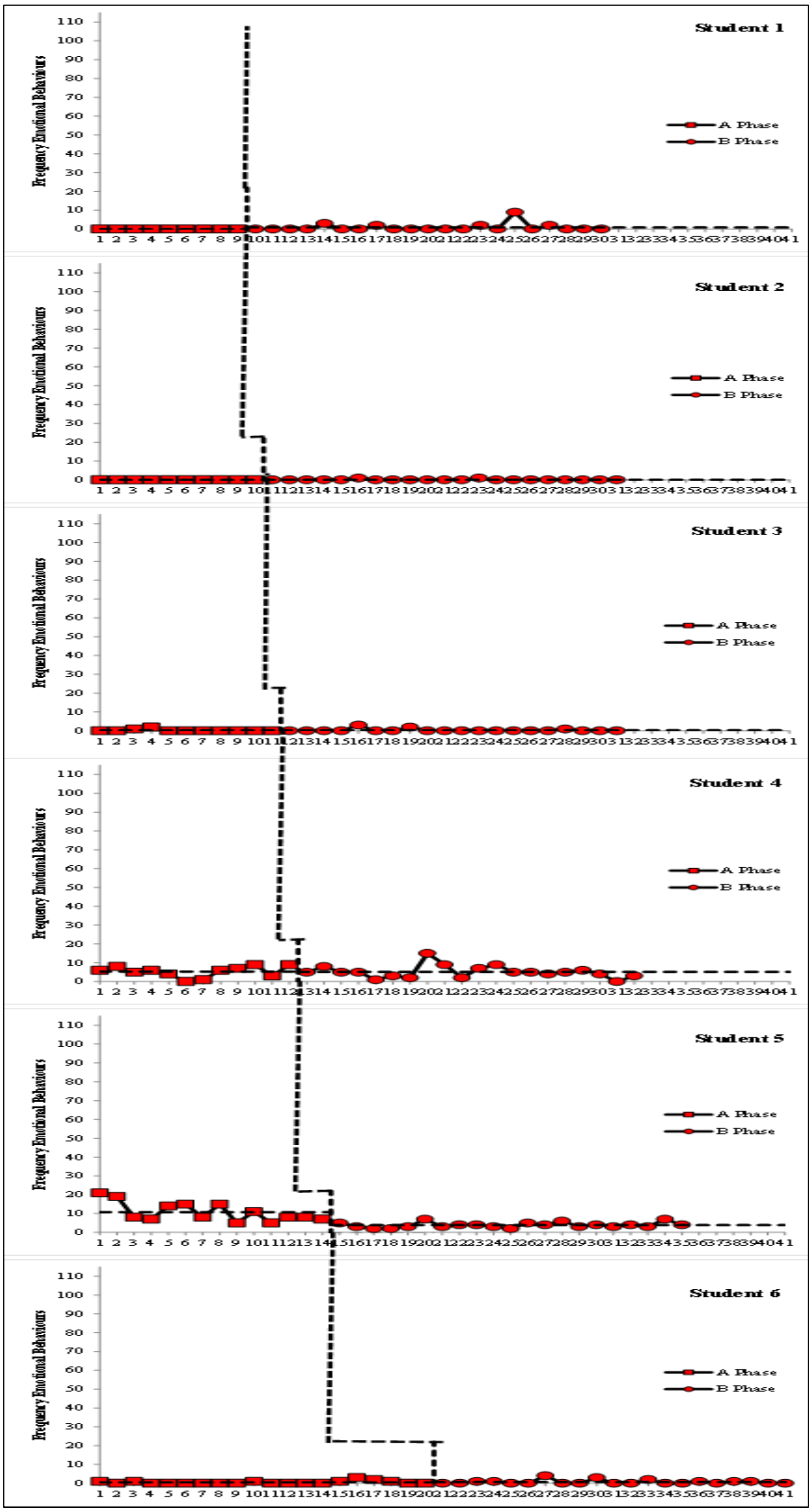


Figure 4-8. *Frequency of emotional behaviours in a routine school day, 2013*

Table 4-12 contains NAP and R-IRD scores (at 95% confidence level) for the students in 2013. In the table, NAP scores are interpreted as *small effect* (values in the

range 0-0.31), *medium effect* (0.32-0.84), and *large effect* (0.85-1.0) (Parker & Vannest, 2009). R-IRD scores are interpreted as *small effect* (0-0.50), *medium effect* (0.50-0.70), *large effect* (0.71-0.75), and *very large effect* (0.75-1.00) (Parker & Vannest, 2009).

Table 4-12. *R-IRD and NAP scores for frequency of emotional behaviours, 2013*

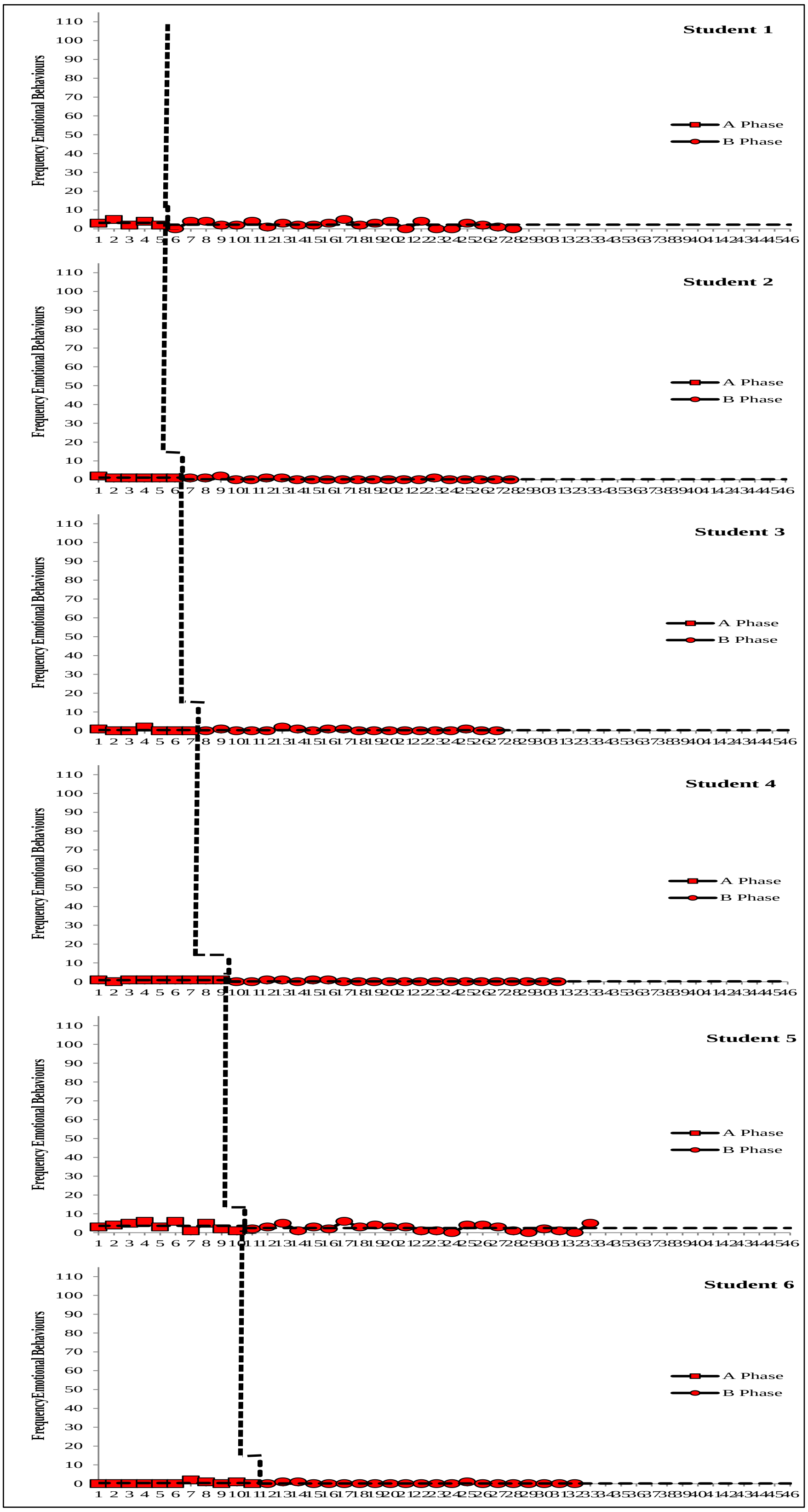
Student	***Lower limit***	***Upper limit***	***R-IRD***	***Effect***	***NAP***	***Effect***
1	*-0.390*	*0.318*	*-0.13*	*Negative*	*-0.24*	*Negative*
2	*-0.272*	*0.501*	*0.10*	*Small (none)*	*-0.10*	*Negative*
3	*-0.254*	*0.525*	*0.14*	*Small (none)*	*0.02*	*Small (none)*
4	*-0.400*	*0.335*	*-0.07*	*Negative*	*0.14*	*Small*
5	*0.393*	*0.938*	*0.76*	*Very large*	*0.93*	*Large*
6	*-0.359*	*0.314*	*-0.03*	*Negative*	*-0.09*	*Negative*

Note: Here “(none)” indicates the result is treated as no effect.

Overall results indicated that there was a negative effect indicating some increase in frequency of emotional behaviours for 50% (calculated effect sizes for 3 out of 6 students) a small effect for 33% (calculated effect sizes for 2 out of 6 students) and a large effect for 17% (calculated effect size for one student). The effect size calculations for student 1 (R-IRD = -0.13), student 4 (R-IRD = -0.07) and student 6 (R-IRD = -0.03) indicated a very small increase in the frequency of emotional behaviours as evident in Table 4-12, which was in agreement for student 1 and student 6 with the NAP effect and visual analysis. However, the NAP indices for student 4 (NAP = 0.14) indicated a small decrease. The R-IRD and NAP scores indicated decreased frequency of emotional behaviours for student 3 (R- IRD = 0.14, NAP = 0.02). However, it is interpreted as no effect due to its small effect size. Scores indicated very large decrease for student 5 (R-IRD = 0.76, NAP = 0.93); the R-IRD score for student 2 (R-IRD = 0.10, NAP = -0.10) indicated decrease in the frequency of emotional behaviours interpreted as no effect due to the small effect, while the NAP score indicated a small increase in the emotional behaviours. Visual analysis was consistent with the reported NAP increase in the frequency of emotional behaviours for student 2. Small to large effect sizes suggested decrease in the frequency of emotional behaviours, as observed through visual analysis for 50% (3 out of 6 students), a small increase indicated by negative effect for 33% (two students) and no effect for 16% (one student).

Frequency of emotional behaviours for 2014

Figure 4-9 shows the frequency of emotional behaviours during the implementation of the sensory integration intervention (by student OTs) in 2014.


Student 1
Student 2
Student 3
Student 4
Student 5
Student 6
Frequency Emotional Behaviours
A Phase
B Phase
110
100
90
80
70
60
50
40
30
20
10
0

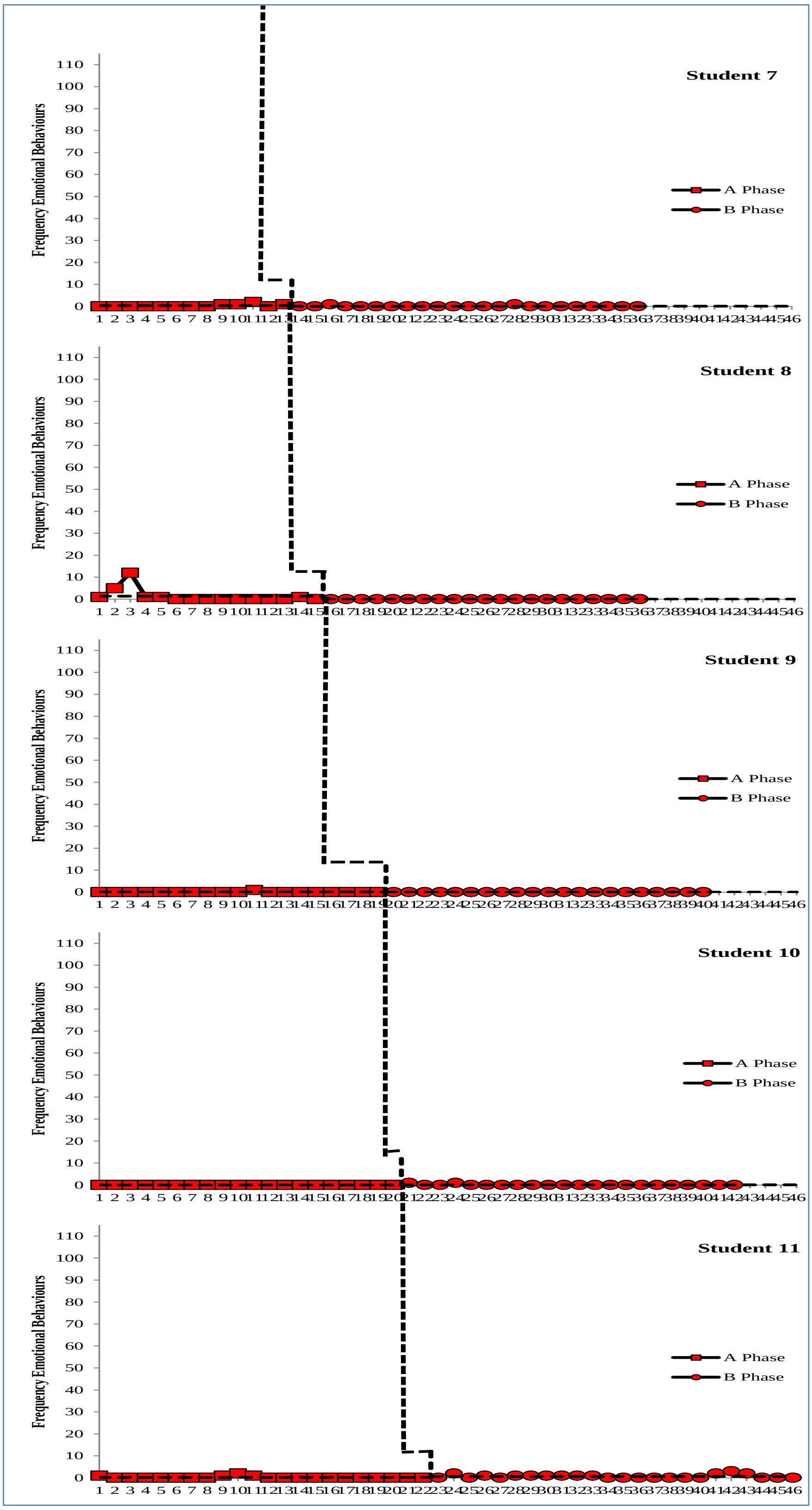


Figure 4-9. *Frequency of emotional behaviours in a routine school day, 2014*

.

Table 4-13 contains NAP and R-IRD scores (at 95% confidence level) for the students in 2014. In the table, NAP scores are interpreted as *small effect* (values in the range 0-0.31), *medium effect* (0.32-0.84), and *large effect* (0.85-1.0) (Parker & Vannest, 2009). R-IRD scores are interpreted as *small effect* (0-0.50), *medium effect* (0.50-0.70), *large effect* (0.71-0.75), and *very large effect* (0.75-1.00) (Parker & Vannest, 2009).

Table 4-13. *R-IRD and NAP scores for frequency of emotional behaviours, 2014*

Student	Lower limit	Upper limit	R-IRD	Effect	NAP	Effect
1	-0.217	0.056	-0.46	Negative	0.34	Small
2	-0.078	0.761	0.36	Medium	0.73	Medium
3	-0.314	0.419	-0.06	Negative	0.01	Small (none)
4	0.197	0.911	0.66	Medium	0.71	Medium
5	-0.166	0.583	0.21	Small (none)	0.34	Medium
6	-0.157	0.599	0.24	Small (none)	0.14	Small
7	-0.084	0.635	0.30	Small (none)	0.23	Small
8	0.102	0.759	0.49	Medium	0.40	Medium
9	-0.276	0.413	0.08	Small (none)	0.05	Small (none)
10	-0.402	0.270	-0.07	Negative	-0.09	Negative
11	-0.536	0.090	-0.25	Negative	-0.35	Negative

Note: Here “(none)” indicates the result is treated as no effect.

Overall results indicated negative effect for 36% (calculated effect sizes for 4 out of 11 students) signifying some increase in frequency of emotional behaviours, and a small to medium effect for 64% (calculated effect sizes for 7 out of 11 students). The calculated effect in Table 4-13 indicated a negative effect identified by a small increase in the frequency of emotional behaviours for student 1 (R-IRD = -0.46), student 3 (R-IRD = -0.06), student 10 (R-IRD = -0.07) and student 11 (R-IRD = -0.25). Effect size calculations using NAP supported R-IRD analysis for student 10 (NAP = -0.09) and student 11 (NAP = -0.35) with the frequency of emotional behaviours during the intervention negligibly more than the baseline (i.e., B > A). The R-IRD scores for student 1 (R-IRD = -0.46, NAP = 0.34) and student 3 (R-IRD = -0.06, NAP = 0.01) indicated a small increase in the frequency of emotional behaviours which was not consistent with the respective NAP scores that indicated a decrease. Visual analysis of Figure 4-9 was consistent with the NAP values. The R-IRD values for student 2 (R-IRD = 0.36), student 5 (R-IRD = 0.21), student 6 (R-IRD = 0.24), student 7 (R-IRD = 0.30), student 8 (R-IRD = 0.49) and student 9 (R-IRD = 0.08) indicated a small effect identified by a decrease in the frequency of emotional behaviours; however, this small decrease in R-IRD values is interpreted as no effect. Visual analysis and the NAP scores were consistent with the reported decrease in the frequency of emotional behaviours. R-IRD indicated a medium decrease in the frequency of emotional behaviours for student 4 (R-IRD = 0.66), consistent with visual analysis and the NAP score. The overall visual analysis indicated that there was a decrease in frequency of emotional behaviours for 82 % (9 out of 11 students) and a small increase for 18% (2 out of 11 students).

Duration of emotional behaviours

Duration of emotional behaviour data were gathered by direct observation. Data were collected on participants in a routine day at school for three days each week during the baseline and intervention phases. Duration was established by noting the start time for each incidence of behaviour and its corresponding end time (when behaviour returned to the level before the start time).

Overall effects for duration of emotional behaviours

Overall effect sizes for duration of emotional behaviours across the three years (2012, 2013, and 2014) were calculated from the proportion of non-overlapping pair data (NAP index) for baseline (phase A) and intervention (phase B). At a zero chance level, NAP scores are interpreted as *small effect* (values in the range 0-0.31), *medium effect* (0.32-0.84), and *large effect* (0.85-1.0) (Parker & Vannest, 2009). NAP values and effects are presented in Table 4-14.

A lower mean during the intervention phase (in the table, B < A) was considered a desirable outcome for the duration of emotional behaviours, as this means those behaviours were less frequent during the intervention phase then pre-intervention. The B < A results were depicted as ‘negative’ (#) during the analysis.

Table 4-14. *Overall NAP scores for duration of emotional behaviours*

		Student										
Year		***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***	***11***
2012	*NAP*	*0.57 B>A ** *	*0.48 B<A #*	*0.46 B<A #*	*0.45 B<A #*	*0.70 B<A #*	*0.94 B<A #*					
2013	*NAP*	*0.24 B>A * *	*0.10 B>A * *	*0.05 B<A #*	*0.10 B<A #*	*0.80 B<A #*	*0.05 B<A #*					
2014	*NAP*	*0.58 B<A #*	*0.72 B<A #*	*0.03 B>A * *	*0.71 B<A #*	*0.25 B<A #*	*0.17 B<A #*	*0.23 B<A #*	*0.40 B<A #*	*0.05 B<A #*	*0.09 B>A * *	*0.32 B>A * *

Note: * small effect, ** medium effect, *** large effect, # negative effect

Overall results from Table 4-14 indicated lower intervention (phase B) scores compared to baseline (phase A) scores (that is, B < A) were identified for 74% of students (calculated effect sizes for calculated effect sizes for 17 of the 23 effect sizes calculated based on individual data across 2012, 2013 and 2014), signifying a decrease in duration of emotional behaviours. Small effect or increase in duration of emotional behaviours (B > A) was indicated for 26% (calculated effect sizes for 6 out of 23 students).

The overall R-IRD scores indicated 87% (calculated individual scores for 20 out of 23 participants across 2012, 2013 and 2014) decreased in the duration of emotional behaviours.

Duration of emotional behaviours for 2012

Figure 4-10 shows the duration of emotional behaviours during the implementation of the sensory integration intervention (by classroom teachers) in 2012. The figure shows the duration of emotional behaviours during a routine day, with the x-axis showing the session number and the y-axis the duration of emotional behaviours for the student.

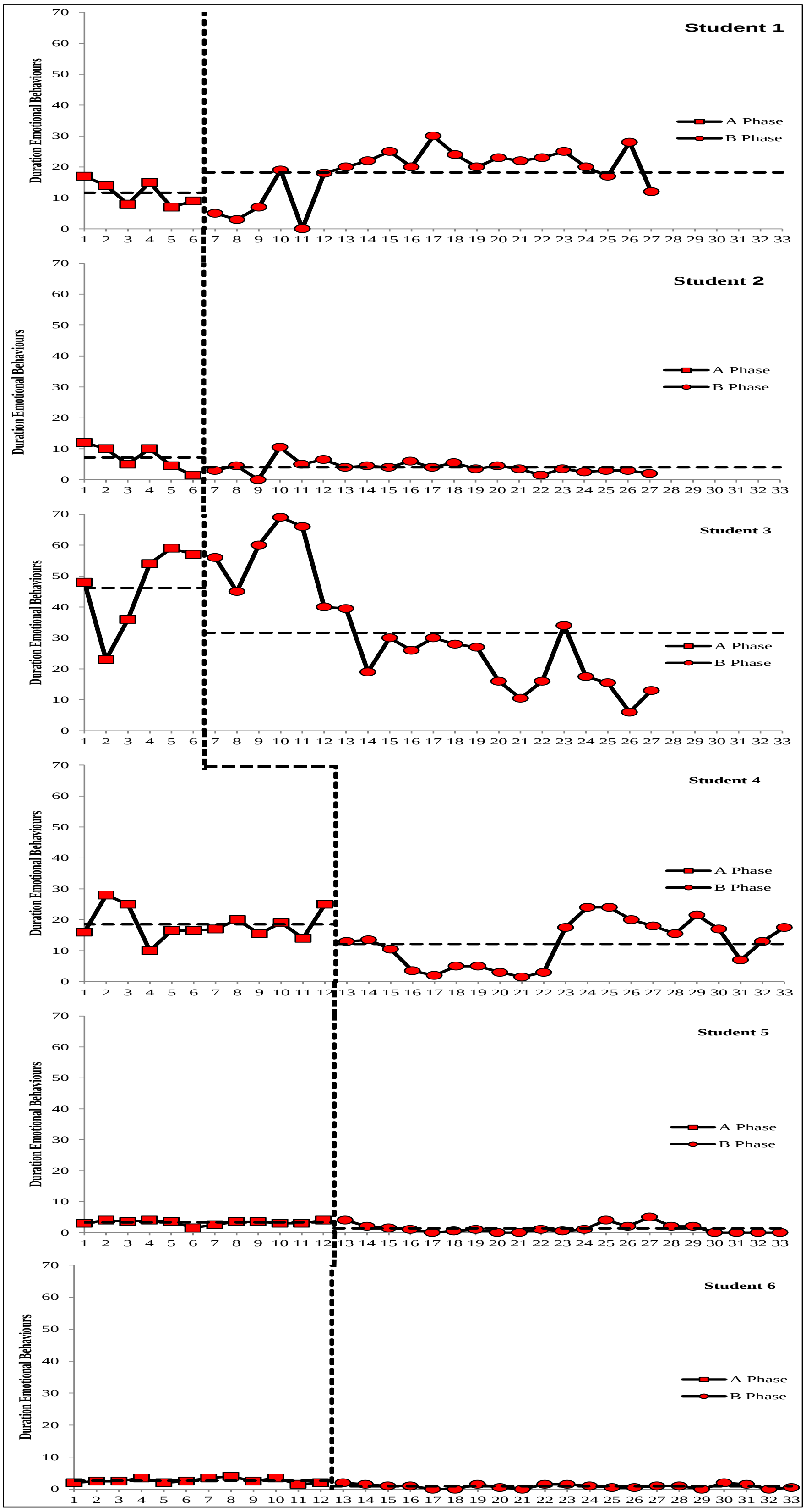


Figure 4-10. *Duration of emotional behaviours in a routine school day, 2012*

Table 4-15 contains NAP and R-IRD scores (at 95% confidence level) for the students in 2012. In the table, NAP scores are interpreted as *small effect* (values in the range 0-0.31), *medium effect* (0.32-0.84), and *large effect* (0.85-1.0) (Parker & Vannest, 2009). R-IRD scores are interpreted as *small effect* (0-0.50), *medium effect* (0.50-0.70), *large effect* (0.71-0.75), and *very large effect* (0.75-1.00) (Parker & Vannest, 2009).

Table 4-15. *R-IRD and NAP scores for duration of emotional behaviours, 2012*

Student	***Lower limit***	***Upper limit***	***R-IRD***	***Effect***	***NAP***	***Effect***
1	*-0.286*	*0.339*	*-0.18*	*Negative*	*-0.57*	*Negative, medium*
2	*-0.100*	*0.756*	*0.35*	*Small (none)*	*0.48*	*Medium*
3	*-0.246*	*0.523*	*0.04*	*Small (none)*	*0.46*	*Medium*
4	*-0.116*	*0.622*	*0.28*	*Small (none)*	*0.45*	*Medium*
5	*0.270*	*0.896*	*0.67*	*Medium*	*0.70*	*Medium*
6	*0.342*	*0.932*	*0.74*	*Large*	*0.94*	*Large*

Note: Here "(none)" indicates the result is treated as no effect.

For five out of six students in 2012, the NAP index indicated a medium to large effect size signifying a decrease in the cumulative duration of emotional behaviours during the intervention (phase B) (that is, B < A) through a routine day at school (see Table 4-15). According to overall visual analysis from Figure 4-10 and R-IRD as observed in Table 4-15 indicated a large increase in the duration of emotional behaviour for student 1 (R-IRD = -0.93, NAP = -0.57); this finding was consistent with the corresponding NAP score. The R-IRD for student 2 (R-IRD = 0.35, NAP = 0.48), student 3 (R-IRD = 0.04, NAP = 0.46) and student 4 (R-IRD = 0.28, NAP = 0.45) indicated a small decrease in the duration of emotional behaviours, supported by their NAP scores and visual analysis. The small decrease in the R-IRD for the duration of emotional behaviours is interpreted as no effect. The R-IRD for student 5

(R-IRD = 0.67, NAP = 0.70) and student 6 (R-IRD = 0.74, NAP = 0.94) indicated a large decrease in the duration of emotional behaviours supported by their NAP scores and visual analysis.

Duration of emotional behaviours for 2013

Figure 4-11 shows the duration of emotional behaviours during the implementation of the sensory integration intervention (by classroom teachers with OT supervision) in 2013.

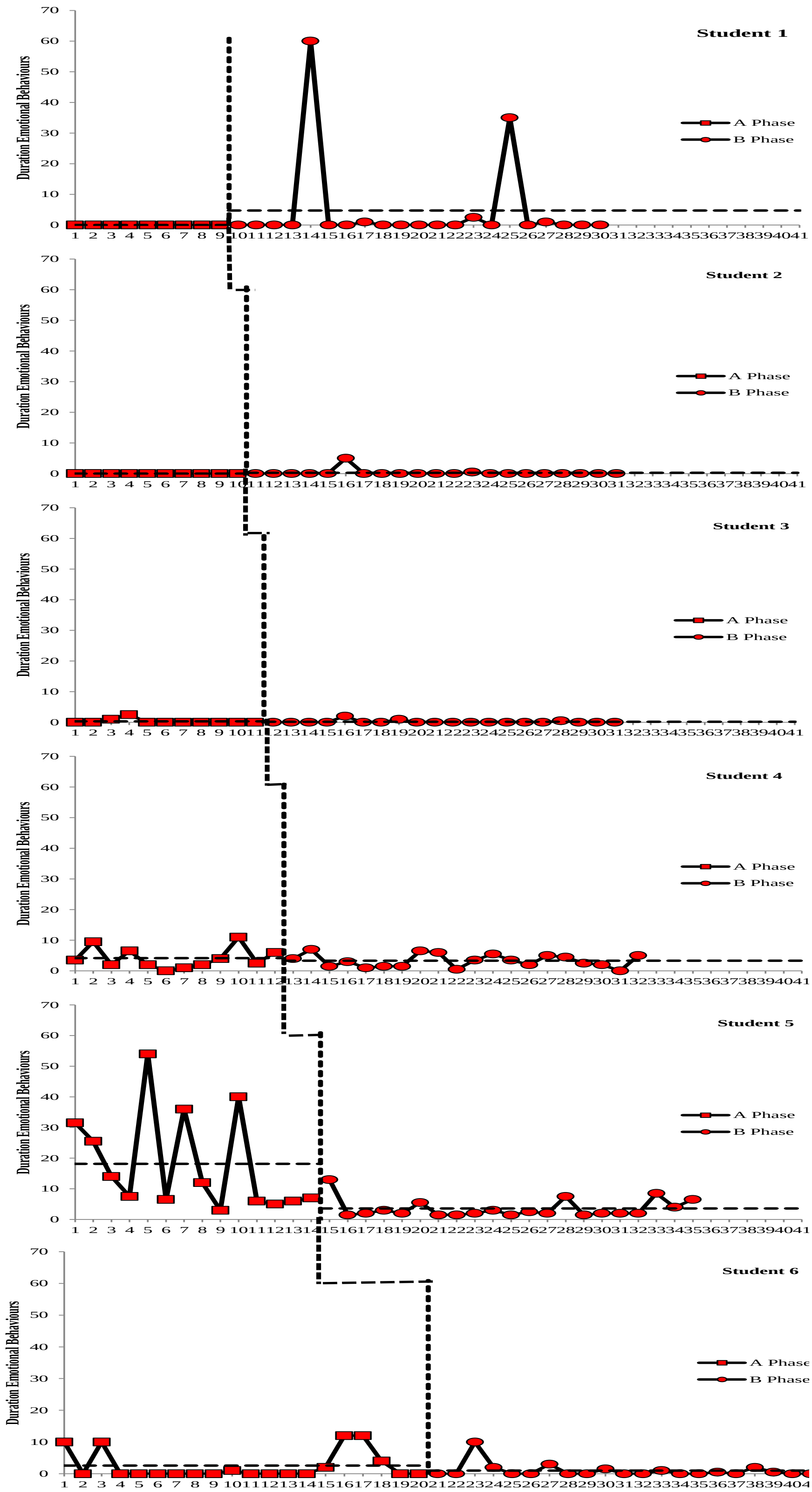


Figure 4-11. *Duration of emotional behaviours in a routine school day, 2013*

Table 4-16 contains NAP and R-IRD scores (at 95% confidence level) for the students in 2013. In the table, NAP scores are interpreted as *small effect* (values in the

range 0-0.31), *medium effect* (0.32-0.84), and *large effect* (0.85-1.0) (Parker & Vannest, 2009). R-IRD scores are interpreted as *small effect* (0-0.50), *medium effect* (0.50-0.70), *large effect* (0.71-0.75), and *very large effect* (0.75-1.00) (Parker & Vannest, 2009).

Table 4-16. *NAP and R-IRD scores for duration of emotional behaviours, 2013*

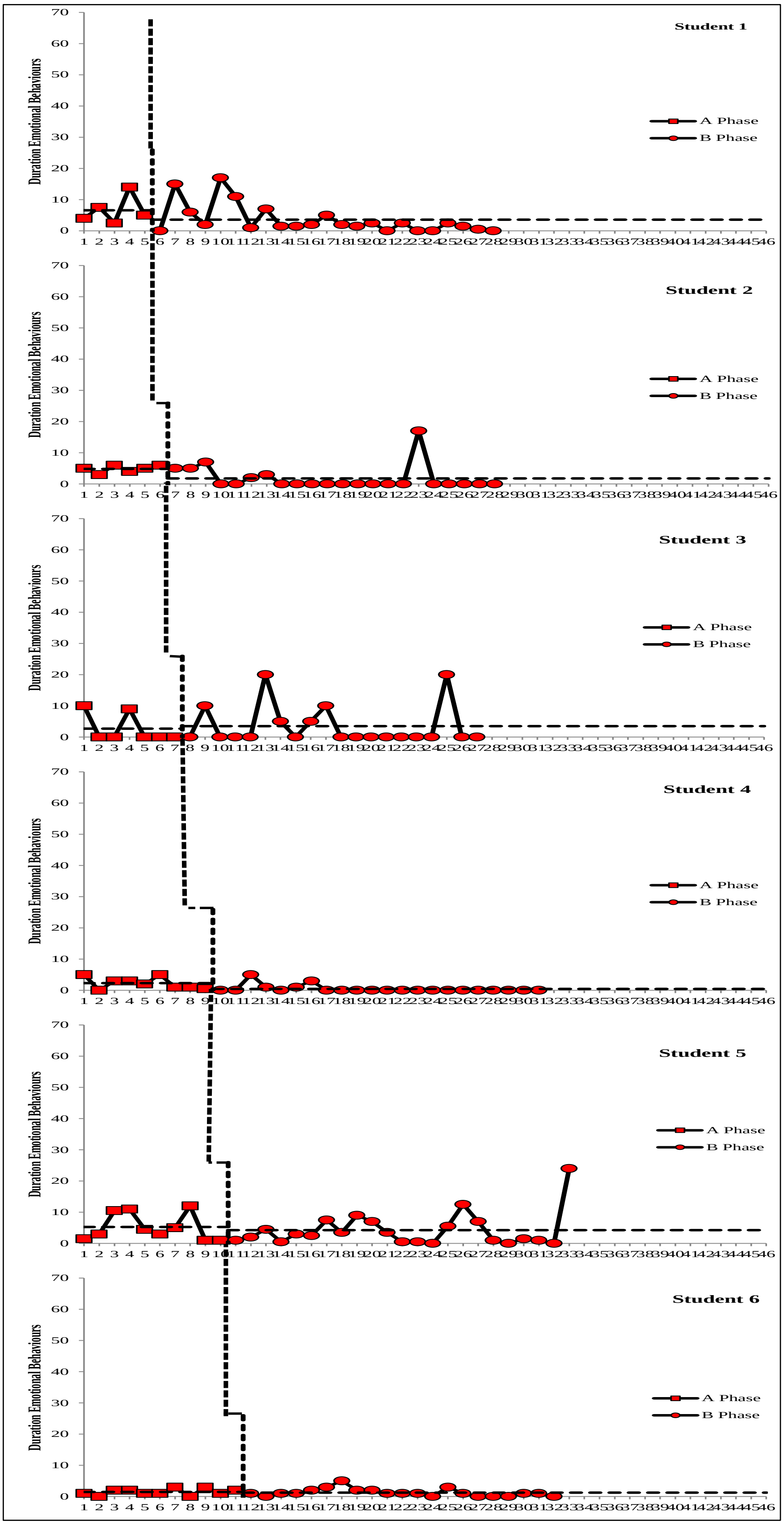
Student	***Lower limit***	***Upper limit***	***R-IRD***	***Effect***	***NAP***	***Effect***
1	*-0.289*	*0.468*	*0.05*	*Small (none)*	*0.24*	*Small*
2	*-0.272*	*0.501*	*0.10*	*Medium*	*0.10*	*Small*
3	*-0.232*	*0.535*	*0.16*	*Medium*	*0.05*	*Small (none)*
4	*-0.444*	*0.274*	*-0.13*	*Negative*	*-0.10*	*Negative*
5	*0.153*	*0.776*	*0.52*	*Medium*	*0.80*	*Medium*
6	*-0.271*	*0.402*	*0.07*	*Small (none)*	*0.02*	*Small (none)*

Note: Here “(none)” indicates the result is treated as no effect.

Overall results indicated a small to medium change signifying decrease in cumulative duration of emotional behaviours for 83% (calculated effect sizes for 5 out of 6 students) and a small increase for 17% (calculated effect sizes for one student). Individual R-IRD effect sizes observed for student 2 (R-IRD = 0.05), student 3 (R-IRD = 0.16), student 4 (R-IRD = 0.16), student 5 (R-IRD = 0.52) and student 6 (R-IRD = 0.07) indicated a small to medium decrease in the duration of emotional behaviours in 2013 (see Table 4-16). However, NAP for student 1 and student 2 indicated a negligible increase in the duration of emotional behaviours, while supporting the small decrease of duration in emotional behaviour for student 3 and student 6; visual analysis from Figure 4-11 was consistent with the NAP score indicating a decrease for student 2, student 3 and student 6. Effect size for student 4 (R-IRD = -0.13, NAP = 0.10) indicated a small increase in the duration, while the NAP score indicated a small decrease in the duration, visual analysis was consistent with the NAP score. R-IRD and NAP scores agreed for student 5 (R-IRD = 0.52, NAP = 0.80) with a moderate decrease in the duration of emotional behaviours, consistent with visual analysis.

Duration of emotional behaviours for 2014

Figure 4-12 shows the duration of emotional behaviours during the implementation of the sensory integration intervention (by student OTs under supervision of expert OTs) in 2014. The figure shows the duration of emotional behaviours during a routine day, with the x-axis showing the session number and the y-axis the duration of emotional behaviours for the student.


Student 1
Student 2
Student 3
Student 4
Student 5
Student 6
A Phase
B Phase
Duration Emotional Behaviours
0
10
20
30
40
50
60
70

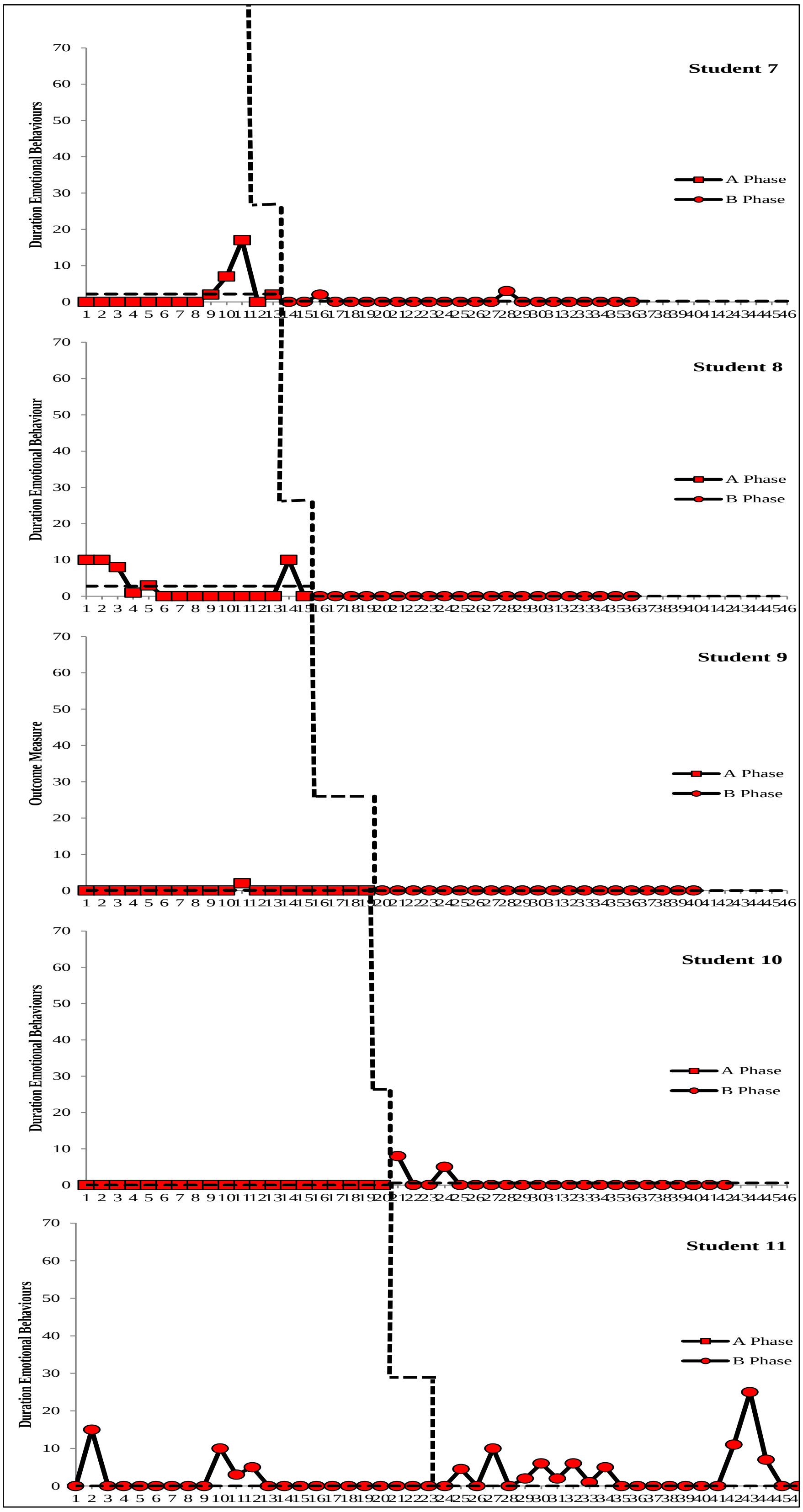


Figure 4-12. *Duration of emotional behaviours in a routine school day, 2014*

Table 4-17 contains NAP and R-IRD scores (at 95% confidence level) for the students in 2014. In the table, NAP scores are interpreted as *small effect* (values in the range 0-0.31), *medium effect* (0.32-0.84), and *large effect* (0.85-1.0) (Parker & Vannest, 2009). R-IRD scores are interpreted as *small effect* (0-0.50), *medium effect* (0.50-0.70), *large effect* (0.71-0.75), and *very large effect* (0.75-1.00) (Parker & Vannest, 2009).

Table 4-17. *NAP and R-IRD scores for duration of emotional behaviours, 2014*

Student	***Lower limit***	***Upper limit***	***R-IRD***	***Effect***	***NAP***	***Effect***
1	*-0.204*	*0.546*	*0.03*	*Small (none)*	*0.58*	*Medium*
2	*-0.078*	*0.761*	*0.36*	*Small (none)*	*0.72*	*Medium*
3	*-0.332*	*0.410*	*-0.08*	*Negative*	*-0.03*	*Negative*
4	*0.090*	*0.827*	*0.53*	*Medium*	*0.71*	*Medium*
5	*-0.267*	*0.464*	*0.07*	*Small (none)*	*0.25*	*Small*
6	*-0.213*	*0.543*	*0.17*	*Small (none)*	*0.17*	*Small*
7	*-0.046*	*0.655*	*0.34*	*Small (none)*	*0.23*	*Small*
8	*0.086*	*0.753*	*0.48*	*Small (none)*	*0.40*	*Medium*
9	*-0.276*	*0.413*	*0.08*	*Small*	*0.05*	*Small (none)*
10	*-0.402*	*0.270*	*-0.07*	*Negative*	*-0.09*	*Negative*
11	*-0.435*	*0.195*	*-0.13*	*Negative*	*-0.32*	*Negative*

Note: Here "(none)" indicates the result is treated as no effect.

Overall results for the cumulative duration of emotional behaviours experienced by the students in a routine school day indicated a medium decrease for 36% (calculated effect sizes for 4 out of 11 students), a small decrease for 36% (calculated effect sizes for 4 out of 11 students) and a small increase for 26% (calculated effect sizes for 3 out of 11 students). As illustrated by Table 4-17, R-IRD for student 1 (R-IRD = 0.03), student 2 (0.36), student 5 (R-IRD = 0.07), student 6 (R-IRD = 0.17), student 7 (R-IRD = 0.34), student 8 (R-IRD = 0.48) and student 9 (R-IRD = 0.08) indicated a small decrease interpreted as no effect in the duration of emotional behaviours; these findings were supported by the NAP scores indicating a small decrease of the behaviours. R-IRD for student 3 (R-IRD = -0.08), student 10 (R-IRD = -0.07) and student 11 (R-IRD = -0.13) indicated a small increase in the duration of emotional behaviours. The NAP findings and visual analysis from Figure 4-12 were consistent with this small increase in the duration of emotional behaviours for the three students. The duration of emotional behaviours for student 4 (R-IRD = 0.53, NAP = 0.71) indicated a medium decrease as indicated by both R-IRD and NAP scores, also consistent with visual analysis.

Visual analysis and comparison of the effect size for the frequency and duration of the emotional behaviours across all years indicated that a reduced frequency coincided with the reduced duration for student 4, student 5 and student 6 in 2012, student 4, and student 5 in 2013, and student 1, student 2, student 4, student 5, student 6, student 7, student 8, and student 9 in 2014. However, for some participants (i.e. student 2 and student 3 in 2012, student 3 and student 6 in 2013, and student 11 in 2014) a decrease in the duration of emotional behaviours was observed despite the small increase in the frequency of emotional behaviours. Conversely, the duration of emotional behaviours increased even when the frequency decreased for student 1 in 2012, student 1 in 2013 and, student 3 and student 10 in 2014 (see Tables 4-10 and 4-14). There appeared to be one incident of emotional behaviour during the baseline and intervention observations for student 2 in 2013, signifying that the SI intervention may have had no effect; the one incident over the 31 days of baseline and intervention observations does not provide sufficient information.

Repeated measures design data

The overall sensory processing sensory scores and the various subscale scores (balance & motion, body awareness, hearing, planning & ideas, social participation, touch, taste, and vision) were obtained using the SPM.

This section consists of the following:

1. Assessing the validity of comparing year groups
2. How SPM scores are reported
3. SPM results for 2012
4. SPM results for 2013
5. SPM results for 2014
6. Analysis of patterns of significance

Assessing the validity of comparing year groups

To evaluate changes in sensory subscales and overall sensory processing, a series of one-way ANOVAs was completed to compare year-group (2012, 2013, and 2014) performance on baseline (T0) raw scores from the SPM. The purpose of this analysis was to identify if the three year-groups of children had significant differences (across years) before the intervention was started. These results would influence subsequent analysis as significant differences between year-groups at baseline (T0) would mean that any subsequent between-group analyses at post-observation (T1) and maintenance (T2) could not be attributed to the intervention alone, as significant differences already existed between each year-cohort at baseline as evident in the following Table 4-18.

Table 4-18. *Summary of one-way ANOVA results at baseline T0*

Sensory subscales	*df*	F	Means square	*p*
Total	2, 20	54.31	7591.18	0.00*
Social Participation	2, 20	3.9	32.20	0.04*
Balance and Motion	2, 20	31.93	379.97	0.00*
Body Awareness	2, 20	6.98	150.42	0.01*
Planning and Ideas	2, 20	35.71	821.45	0.00*
Touch	2, 20	20.16	188.47	0.00*
Taste & smell	2, 20	10.03	48.22	0.00*
Vision	2, 20	24.09	118.13	0.00*
Hearing	2, 20	0.17	76.25	0.85

** indicates significant at $p < 0.05$*

One-way ANOVA results identified significant differences between each year-group at T0 on the SPM Total raw score and on the subscale raw scores for Social Participation, Balance & Motion, Body Awareness, Planning & Ideas, Touch, Taste and Vision. Results showed that between-year groups were not significantly different on measures of the subscale scores of Hearing.

Since there were significant differences between scores (see Table 4-18), comparisons between years could not be made, as changes in results could not be attributed to the intervention alone. However, later in this chapter, findings from the repeated measures ANOVA and ExPRT (v.2.1) will be compared year-wise only to explore whether the different styles of intervention had any influence on the outcomes.

Another reason for keeping analysis to within-year level was that the intervention was implemented by individuals with different expertise and different qualifications, in each year of the study. In 2012, the intervention was delivered by classroom staff in consultation with an OT, where the OT did not have access to the classroom. In 2013, it was delivered by the classroom staff guided by fortnightly observations by an expert OT, and then was delivered entirely by student OTs under supervision of expert OTs in 2014.

It is important to acknowledge that the number of participants for this type of analysis was small and that the SPM sensory subscale scores were considered a secondary analysis to that data collected from direct observations (during the multiple-baseline SCED). The analysis focused on within-year groups, and the variance for between-year groups was investigated only to explore the extent to which outcomes changed when the intervention was delivered by expert OTs. The results of the tests of variance for within-year participant groups are discussed in the next section.

How SPM results are reported

A repeated measures ANOVA was conducted to compare baseline (T0), post-observation (intervention) (T1), and maintenance (T2) scores. This analysis helped to identify the sensory subscales that showed improvement. As shorthand, a comparison of the T0 and T1 phases is written as 'T0-T1', a comparison of T1 and T2 phases is written as 'T1-T2' and a comparison of T0 and T2 phases is written as 'T0-T2'.

Sustained improvement was indicated by significant changes in T0-T1 and T0-T2, but not T1-T2, as this meant that change was retained in T2 (change in T0-T2) and did not keep increasing after the invention ceased (no change in T1-T2).

Unsustained improvement was shown by significant change in T0-T1, but not T1-T2 and not T0-T2, as this meant the significant change in T1 was lost by T2.

In terms of specific scores, on the SPM, scores from 40-60 represent expected development, from 60-70 represent having some problems, and scores higher than 70 represent having definite dysfunction. Reducing scores over time therefore indicate improvement.

SPM results for 2012

In 2012, the sensory integration intervention was implemented by teachers with once a fortnight consultation with an OT. Table 4-19 contains a summary of the significance of changes on the sensory subscales between the phases for 2012.

Table 4-19. *Summary of changes on sensory subscales, 2012*

Subscale	Phases	Mean Difference	Std. Error	Sig. *p*	95% Confidence Interval for Difference	
					Lower bound	Upper bound
Total	T0-T1	21.25	3.34	0.00*	12.52	29.99
	T0-T2	13.67	3.68	0.004*	4.06	23.28
	T1-T2	-	-	-	-	-
Balance & Motion	T0-T1	18.62	0.75	0.00 *	17.05	20.18
	T0-T2	13.81	0.74	0.03 *	12.26	15.37
	T1-T2	-	-	-	-	-
Body Awareness	T0-T1	15.35	1.01	0.01 *	13.25	17.45
	T0-T2	-	-	-	-	-
	T1-T2	-	-	-	-	-
Hearing	T0-T1	19.18	4.64	0.00 *	9.49	28.86
	T0-T2	12.10	0.643	0.00 *	10.75	13.44
	T1-T2	-	-	-	-	-
Planning & Ideas	T0-T1	-	-	-	-	-
	T0-T2	-	-	-	-	-
	T1-T2	-	-	-	-	-
Social Participation	T0-T1	-	-	-	-	-
	T0-T2	-	-	-	-	-
	T1-T2	-	-	-	-	-
Taste & Smell	T0-T1	-	-	-	-	-
	T0-T2	-	-	-	-	-
	T1-T2	-	-	-	-	-
Touch	T0-T1	9.00	1.00	0.00 *	5.47	12.53
	T0-T2	-	-	-	-	-
	T1-T2	-	-	-	-	-
Vision	T0-T1	10.00	1.24	0.00 *	5.62	14.38
	T0-T2	-	-	-	-	-
	T1-T2	-	-	-	-	-

Note: * indicates significant difference, - indicates no difference

Table 4-19 indicates that the Total sensory subscale scores and scores across Balance & Motion and Hearing, were significantly different at post-observation (T0-T1) and maintenance (T0-T2) compared with baseline scores; Body Awareness, Touch and Vision were significantly different at post-observation (T0-T1). However, the significant difference was not maintained between the post-observation and maintenance scores (T1-T2) for these sensory subscales. This result meant that once the fidelity to the intervention elements was withdrawn, so were the gains. The children still had access to the equipment and activities, but staff did not insist on the fidelity elements, while maintaining supervision for safety purpose. There was no change observed in the sensory subscales of Planning and Ideas, Social Participation and Taste.

Details of the various sensory subscales are included in the remainder of this subsection.

SPM Total Raw Score. A significant difference in SPM scores across time was identified for the SPM total raw score [F (2, 10) = 24.79, $p = 0.00$]. Bonferroni post-hoc tests identified a significant difference in the SPM Total raw score from T0-T1 ($p = 0.00$), with the mean score at baseline (T0 = 125.17) being significantly higher than the mean score at post-observation (T1 = 68.67). A significant difference between baseline (T0 = 125.17) and maintenance (T2 = 84.50) was also identified ($p = 0.04$). No significant difference between post-observation and maintenance was identified ($p = 0.18$). This indicates that significant changes in the overall ability of the students in sensory processing took place during the intervention, as opposed to the maintenance phase of the programme.

SPM Balance & Motion Raw Score. A significant difference in SPM scores across time was identified for the SPM Balance & Motion raw score [F (2, 10) = 16.60, $p = 0.00$]. Bonferroni post-hoc tests identified that there was a significant difference in the SPM Balance & Motion raw score from baseline to post-observation where the mean score at baseline (T0 = 26.17) was observed to be higher than the mean score at post-observation (T1 = 14.67) and was significant (*p* = 0.00). This significant difference was also identified between baseline mean score (T0 = 26.17) to maintenance mean scores (T2 = 18.00) (*p* = 0.03). There was no significant difference between the SPM raw score between post-observation (T1 = 14.67) to maintenance (T2 = 18.00) where (*p* = 0.75). This indicates that significant changes in the student ability for Balance and Motion took place during the intervention phase as opposed to the maintenance phase of the programme.

SPM Body Awareness Raw Score. A significant difference in SPM scores across time was identified for the SPM Body Awareness raw score [*F* (2, 10) = 5.13, *p* = 0.03]. The mean raw scores for Body Awareness at baseline were (T0 = 20.33), post-observation (T1 = 12.00) and maintenance phase (T2 = 15.67). Bonferroni post-hoc tests identified that there was a significant difference between the mean scores at baseline (T0 = 20.33) and post-observation (T1 = 12.00) (*p* = 0.01), but not significant between baseline (T0 = 20.33) and maintenance (T2 = 15.67) (*p* = 0.72). The significance was also absent for post-observation (T1 = 12.00) to maintenance scores (T2 = 15.67) (*p* = 0.56). This indicates that there were significant changes in Body Awareness for students during the intervention phase compared to the maintenance phase.

SPM Hearing Raw Score. A significant difference in SPM scores across time was identified for the SPM Hearing raw score [*F* (2, 10) = 36.18, *p* = 0.00]. Bonferroni post-hoc tests identified that there was a significant difference in the SPM Hearing mean raw score at baseline (T0 = 20.83) being significantly higher than the mean score at post-observation (T1 = 12.00) (p = 0.00). This significant difference was also identified between baseline (T0) and maintenance (T2) where mean raw score at maintenance (T2 = 12.1) was different from the mean score at baseline (T0 = 20.83) (p = 0.00). There was no significant difference between the SPM Hearing raw score between post-observation (T1 = 12.00) to maintenance (T2 = 12.1) (p = 1.00). This indicates that significant change in scores for hearing was observed during intervention phase and sustained during the maintenance phase. There was no change between the scores at post-observation phase and the maintenance phase. This meant change in the raw scores for Hearing occurred during the intervention phase, and did not regress to baseline scores.

SPM Planning & Ideas Raw Score. There was no significant difference in SPM scores across time identified for the SPM Planning & Ideas raw score [F (2, 10) = 3.93, p = 0.05]. The mean raw scores for Planning and Ideas were (T0 = 40.00) at baseline phase, (T1 = 35.67) at the post-observation phase and (T2 = 31.83) at the maintenance phase. These results indicated that SI intervention had no effect on the scores for Planning & Ideas.

SPM Social Participation Raw Score. No significant difference in SPM scores across time was identified for the SPM Social Participation raw score [F (2, 10) = 3.72, p = 0.06]. The mean raw scores for social participation at baseline were (T0 = 39.33), post-observation (T1 = 35.67) and maintenance (T2 = 35.33). These results indicated that SI intervention had no effect on the scores for Social Participation.

SPM Taste & Smell items. No significant difference in SPM scores across time was identified for the SPM Taste raw score [F (2, 10) = 1.99, p = 0.19]. The mean raw scores for taste at baseline were (T0 = 9.33), post-observation (T1 = 7.00) and maintenance (T2 =10.00) respectively. These results indicated that SI intervention had no effect on the scores for Taste.

SPM Touch Raw Score. A significant difference in SPM scores across time was identified for the SPM Touch raw score [F (2, 10) = 19.24, p = 0.00]. Bonferroni post-hoc tests identified that there was a significant difference in the SPM Touch raw score from baseline (T0) to post-observation (T1), with the mean score at baseline (T0 = 21.67) being significantly higher than the mean score at post-observation (T1 = 12.67) (p = 0.00). This significant difference was not observed between baseline (T0) and maintenance (T2 = 14.50) (p = 0.06) or between the SPM raw score between post-observation (T1 = 12.67) and maintenance (T2 = 14.50) (p = 0.65). This indicated there was a significant improvement in the student ability to process touch during the intervention phase, however, the change was not sustained to maintenance phase.

SPM Vision Raw Score. A significant difference in SPM scores across time was identified for the SPM Vision raw score [F (2, 10) = 22.06, p = 0.00]. Bonferroni post-hoc tests identified that there was a significant difference in the SPM Vision raw score from baseline (T0) to post-observation (T1) (p = 0.00), with the mean score at baseline (T0 = 20.33) being significantly higher than the mean score at post-observation (T1 =10.33). This significant difference was not identified between baseline (T0 = 20.33) and maintenance (T2 = 14.17) (p = 0.07) or between the SPM raw score between post-observation (T1 = 10.33) and maintenance (T2 = 14.17) (p = 0.10). This indicated that student ability for vision processing improved significantly during the intervention phase, but was not sustained during the maintenance phase.

SPM results for 2013

In 2013, the sensory integration intervention was implemented by teachers with once-a-fortnight observation and consultation by an OT. Table 4-20 contains a summary of the significance of changes on the sensory subscales between the phases for 2013.

Table 4-20. *Summary of changes on sensory subscales, 2013*

Subscale	Phases	Mean Difference	Std. Error	Sig. *p*	95% Confidence Interval for Difference	
					Lower bound	Upper bound
Total	T0-T1	56.50	6.91	0.04 *	32.07	80.93
	T0-T2	40.67	10.75	0.04 *	2.66	78.67
	T1-T2	-	-	-	-	-
Balance & Motion	T0-T1	5.00	1.03	0.01 *	1.35	8.65
	T0-T2	-	-	-	-	-
	T1-T2	-	-	-	-	-
Body Awareness	T0-T1	-	-	-	-	-
	T0-T2	-51.67	3.36	0.00 *	-63.55	-39.78
	T1-T2	-50.17	3.28	0.00 *	-61.76	-38.57
Hearing	T0-T1	3.50	1.03	0.05 *	-0.12	7.12
	T0-T2	-	-	-	-	-
	T1-T2	-	-	-	-	-
Planning & Ideas	T0-T1	9.50	2.91	0.07 *	-0.77	19.77
	T0-T2	-	-	-	-	-
	T1-T2	-	-	-	-	-
Social Participation	T0-T1	-	-	-	-	-
	T0-T2	-	-	-	-	-
	T1-T2	-	-	-	-	-
Taste & Smell	T0-T1	-	-	-	-	-
	T0-T2	-	-	-	-	-
	T1-T2	-	-	-	-	-
Touch	T0-T1	-	-	-	-	-
	T0-T2	-	-	-	-	-
	T1-T2	-	-	-	-	-
Vision	T0-T1	-	-	-	-	-
	T0-T2	-	-	-	-	-
	T1-T2	-	-	-	-	-

Note: * indicates significant difference, - indicates no difference

There were some mixed patterns in improved sensory processing ability of students in 2013. Table 4-20 indicates that the total scores were significantly different at post-observation and maintenance in 2013. This meant that students' ability for sensory processing improved during the intervention phase and were sustained in the maintenance phase. A significant difference was also observed between post-observation and baseline scores for sensory subscales Balance & Motion and Hearing. This indicated an improved sensory processing ability of students for those subscales during intervention phase that did not continue in the maintenance phase (where staff maintained supervision for safety purpose and did not insist on fidelity to elements of intervention).

Significant differences between the Body Awareness scores at maintenance (T0-T2 and T1-T2) indicated a gradual improvement in Body Awareness. There was an improvement in the Hearing subscale during the intervention phase, but this was not sustained in the maintenance phase. Student ability in processing within the Planning and Ideas subscale was sustained in the maintenance phase, with smaller gains between the post-observation and maintenance phases i.e., T0-T2. This may indicate gradual improvement from baseline to maintenance. There was no change within the sensory subscales for Social Participation and Taste.

Details of the various sensory subscales are included in the remainder of this subsection.

SPM Total Raw Score. There was a significant difference in SPM scores across time for the SPM total raw score [F (2, 10) = 5.10, p = 0.03]. The mean raw scores for sensory processing were at baseline (T0 = 84.00), post-observation (T1 = 66.83) and maintenance (T2 = 74.67). Bonferroni post-hoc tests identified that there was a significant difference in the SPM total raw score from baseline (T0 = 84.00) to post-observation (T1 = 66.83) (p = 0.04) and between baseline (T0 = 84.00) and maintenance (T2 = 74.67) (p = 0.04). However, the significance was not observed between the SPM total raw score between post-observation (T1 = 66.83) to maintenance (T2 = 74.67) ($p = 0.24$). This indicated a significant improvement in the overall sensory processing for students occurred during the intervention phase and was sustained during the maintenance phase.

SPM Balance & Motion Raw Score. A significant difference in the SPM scores across time was identified for the SPM raw score for the Balance and Motion subscale [F (2, 10) = 7.31, $p = 0.01$]. The mean raw scores for Balance and Motion were at baseline (T0 = 17.50), post-observation (T1 = 12.50) and maintenance (T2 = 14.50). Bonferroni post-hoc tests identified that a significant difference was identified between the SPM Balance & Motion raw score from baseline (T0 = 17.50) to post-observation (T1 = 12.50) ($p = 0.01$), but not between baseline (T0 = 17.50) to maintenance (T2 = 14.50) ($p = 0.41$) or between the SPM raw score between post-observation (T1 = 12.50) to maintenance (T2 = 14.50) ($p = 0.41$). This indicated there was a significant improvement in student ability to the processing of Balance & Motion during the intervention phase that were not maintained, but regressed to baseline level.

SPM Body Awareness Raw Score. A significant difference in the SPM scores across time was identified for the SPM Body Awareness raw score [F (2, 10) = 205.98, $p = 0.00$]. Bonferroni post-hoc tests identified that there was no significant difference in the SPM raw score from baseline (T0 = 11.00) to post-observation (T1 = 12.50) ($p = 1.00$). However, a significant difference was identified between baseline (T0 = 11.00) to maintenance (T2 = 62.67) ($p = 0.00$) and between the SPM Body Awareness raw score between post-observation (T1 = 12.50) to maintenance (T2 = 62.67) ($p = 0.00$). This indicated a significant improvement in student ability to the processing of Body Awareness gradually from baseline phase (T0) to maintenance phase (T2), with only a small increase noted at post-observation phase (T1).

SPM Hearing Raw Score. A significant difference in the SPM scores across time was identified for the SPM Hearing raw score [F (2, 10) = 4.85, p = 0.03]. Mean raw scores for Hearing were (T0 = 15.33) at baseline, post-observation (T1 = 11.83) and maintenance (T2 = 14.83). Bonferroni post-hoc tests identified that a significant difference was identified in the SPM Hearing raw score from baseline (T0 = 15.33) to post-observation (T1 = 11.83) (p = 0.01) but not between baseline (T0 = 15.33) to maintenance (T2 = 14.83) (p = 1.00) or between the SPM total raw score between post-observation (T1 = 11.83) to maintenance (T2 = 14.83) (p = 0.10). This indicated improved student ability to the processing of hearing during the intervention phase that was not sustained in the maintenance phase.

SPM Planning & Ideas Raw Score. There was a significant difference in SPM scores across time identified for the SPM Planning & Ideas raw score [F (2, 10) = 4.75, p = 0.04]. Mean raw scores for Planning and Ideas at baseline (T0 = 33.67), post-observation (T1 = 24.17) and maintenance (T2 = 28.17). Bonferroni post-hoc tests indicated that there was no significant difference identified in the SPM raw score from baseline (T0 = 33.67) to post-observation (T1 = 24.17) (p = 0.07), or between post-observation (T1 = 24.17) to maintenance (T2 = 28.17) (p = 0.38), and no significant difference was observed between the SPM Planning & Ideas raw score between baseline (T0) and maintenance (T2) (p = 0.64). This indicated that there was a very slight possibility of significant improvement in student ability to process within the Planning & Ideas subscale gradually from the baseline phase to the maintenance phase.

SPM Social Participation Raw Score. No significant difference in the SPM scores across time was identified for the SPM Social Participation raw score [F (2, 10) = 1.46, p = 0.28]. Mean raw scores for Social Participation were (T0 = 37.00) at baseline, (T1 = 33.17) at post-observation and (T2 = 34.33) at maintenance. This finding indicated that SI intervention had no effect on scores for Social Participation.

SPM Taste & Smell items. No significant difference in the SPM scores across time was identified for the SPM Taste raw score [F (2, 10) = 3.59, p = 0.07]. Mean raw scores for Taste at baseline (T0 = 8.83), post-observation (T1 = 6.83) and maintenance (T2 = 7.00). These results indicated that SI intervention had no effect on the scores for Taste.

SPM Touch Raw Score. There was no significant difference in the SPM scores across time identified for the SPM Touch raw score [F (2, 10) = 1.73, p = 0.23]. Mean raw scores for Touch at baseline (T0 = 15.00), post-observation (T1 = 14.00) and maintenance (T2 = 15.83). These results indicated that SI intervention had no effect on the scores for Touch.

SPM Vision Raw Score. No significant difference in the SPM scores across time was identified for the SPM Vision raw score [F (2, 10) = 1.16, p = 0.35]. Mean raw scores for Vision at baseline (T0 = 13.17), post-observation (T1 = 12.83) and maintenance (T2 = 11.83). These results indicated that SI intervention had no effect on the scores for Vision.

SPM results for 2014

In 2014, the sensory integration intervention was implemented by expert OTs. Table 4-21 contains a summary of the significance of changes on the sensory subscales between the phases for 2012.

Table 4-21. *Summary of changes on sensory subscales, 2014*

Subscale	Phases	Mean Difference	Std. Error	Sig. *p*	95% Confidence Interval for Difference	
					Lower bound	Upper bound
Total	T0-T1			0.03 *		
	T0-T2	-	-	-	-	-
	T1-T2	-	-	-	-	-
Balance & Motion	T0-T1	-	-	-	-	-
	T0-T2	-	-	-	-	-
	T1-T2	-	-	-	-	-
Body Awareness	T0-T1	-	-	-	-	-
	T0-T2	-	-	-	-	-
	T1-T2	-	-	-	-	-
Hearing	T0-T1	-	-	-	-	-
	T0-T2	-	-	-	-	-
	T1-T2	-	-	-	-	-
Planning & Ideas	T0-T1	-	-	-	-	-
	T0-T2	-	-	-	-	-
	T1-T2	-	-	-	-	-
Social Participation	T0-T1	4.18	1.04	0.01 *	1.20	7.17
	T0-T2	-	-	-	-	-
	T1-T2	-	-	-	-	-
Taste & Smell	T0-T1	-	-	-	-	-
	T0-T2	-2.09	0.64	0.03*	-3.92	-0.26
	T1-T2	-	-	-	-	-
Touch	T0-T1	-	-	-	-	-
	T0-T2	-	-	-	-	-
	T1-T2	-	-	-	-	-
Vision	T0-T1	-	-	-	-	-
	T0-T2	-	-	-	-	-
	T1-T2	-	-	-	-	-

Note: * indicates significant difference, - indicates no difference

There were no patterns apparent in the scores across different sensory subscales in 2014. Only the Total for all sensory subscales score and scores for Social Participation were significantly different at post-observation, and the scores for Taste were significantly different at maintenance (see Table 4-21). This indicated that sensory processing ability of students in 2014 improved for Total scores and Social Participation during intervention phase but not during maintenance; whereas, it improved gradually to maintenance phase for Taste with little change from post-observation to maintenance phase. The gains made during the intervention phase regressed once active intervention was withdrawn (that is, staff continued supervision for safety and children had access to the equipment and activities, however, staff did not insist on fidelity to intervention elements). No change was indicated by the repeated measures ANOVA findings for Balance and Motion, Body awareness, Hearing, Planning and Ideas, Touch and Vision subscales.

Details of the various sensory subscales are included in the remainder of this subsection.

SPM Total Raw Score. There was a significant difference in SPM scores across time for the SPM Total raw score [F (2, 20) = 4.27, p = 0.03]. Mean raw scores for sensory processing at baseline (T0 = 62.64), post-observation (T1 = 72.55) and maintenance (T2 = 71.64). Bonferroni post-hoc tests identified a significant difference between the SPM total raw score from baseline (T0 = 62.64) to post-observation (T1 = 72.55) (p = 0.04) but not between baseline (T0 = 62.64) to maintenance (T2 = 71.64) (p = 0.06) or between post-observation (T1 = 72.55) to maintenance (T2 = 71.64) (p = 0.71). This indicated that there was improved student ability in the overall sensory processing during the intervention phase, which was not sustained in the maintenance phase.

SPM Balance & Motion Raw Score. No significant difference in SPM scores across time was identified for the SPM Balance & Motion raw score [F (2, 20) = 2.48, p = 0.11]. The mean raw scores for Balance & Motion at baseline, post-observation and maintenance were (T0 = 12.18), (T1 = 14.27) and (T2 = 13.82), respectively. These results indicated that SI intervention had no effect on the scores for Balance & Motion.

SPM Body Awareness Raw Score. There was no significant difference in SPM scores across time identified for the SPM Body Awareness raw score [F (2, 20) = 3.37, p = 0.06]. Mean raw scores for processing of Body Awareness at baseline, post-observation and maintenance were (T0 = 11.55), (T1 = 13.45) and (T2 = 13.91), respectively. These results indicated that SI intervention had no effect on the scores for Body Awareness.

SPM Hearing Raw Score. No significant difference in SPM scores across time was identified for the SPM Hearing raw score (F (2, 20) = 9.82, p = 0.39). Mean raw scores for sensory processing of Hearing at baseline, post-observation and maintenance were (T0 = 21.36), (T1 = 12.45) and (T2 = 12.36), respectively. These results indicated that SI intervention had no effect on the scores for Hearing.

SPM Planning & Ideas Raw Score. A significant difference in SPM scores across time was not identified for the SPM Planning & Ideas raw score [F (2, 20) = 1.29, p = 0.30]. Mean raw scores for processing of Planning and Ideas at baseline, post-observation and maintenance were (T0 = 20.55), (T1 = 21.64) and (T2 = 22.27), respectively. These results indicated that SI intervention had no effect on the scores for Planning & Ideas.

SPM Social Participation Raw Score. A significant difference in SPM scores across time was identified for the SPM Social Participation raw score [F (2, 20) = 5.49, p = 0.01]. Bonferroni post-hoc tests identified significant difference in the SPM Social Participation raw score from baseline (T0) to post-observation (T1) (p = 0.01) with mean scores at baseline (T0 = 35.27) considerably higher than mean scores at post-observation (T1 = 31.09). However, significance was not observed between baseline (T0 = 35.27) and maintenance (T2 = 32.09) (p = 0.20) or between post-observation (T1 = 31.09) and maintenance (T2 = 32.09) (p = 1.00). This indicated that there was a significant improvement in the Social Participation raw scores for the students during the intervention phase, but this was not sustained during the maintenance phase.

SPM Taste & Smell items. A significant difference in SPM scores across time was identified for the SPM Taste raw score [F (2, 20) = 7.433, p = 0.00]. The mean scores at baseline were (T0 = 5.00), post-observation (T1 = 6.82) and maintenance (T2 = 7.09). Bonferroni post-hoc tests identified that there was no significant difference in the SPM Taste raw score from baseline (T0 = 5.00) to post-observation (T1 = 6.82) (p = 0.07), or between the post-observation (T1 = 6.82) and maintenance (T2 = 7.09) (p = 1.00). However, there was a significant difference between baseline (T0) and maintenance (T2) (p = 0.02), which indicated an improvement in the sensory processing for Taste occurred gradually between the baseline to post-observation and maintenance phases.

SPM Touch Raw Score. There was no significant difference in SPM scores across time identified for the SPM Touch raw score [F (2, 20) = 1.81, p = 0.19]. The mean raw scores at baseline, post-observation and maintenance were (T0 = 11.82), (T1 = 13.18) and (T2 = 13.72), respectively. These results indicated that SI intervention had no effect on the scores for Touch.

SPM Vision Raw Score. A non-significant difference in SPM scores across time was identified for the SPM Vision raw score [$F(2, 20) = 1.04$, $p = 0.37$]. Mean raw scores for processing of Vision at baseline, post-observation and maintenance were (T0 = 10.73), (T1 = 11.73) and (T2 = 10.73), respectively. These results indicated that SI intervention had no effect on the scores for Vision.

Analysis of patterns of significance

Table 4-22 summarises findings for significance of change resulting from intervention across years for 2012, 2013 and 2014.

Table 4-22. *Summary of significant differences within years*

	Year								
Subscale	2012			2013			2014		
	T0-T1	T0-T2	T1-T2	T0-T1	T0-T2	T1-T2	T0-T1	T0-T2	T1-T2
Total	✓	✓	-	✓	✓	-	✓	-	-
Balance & Motion	✓	✓	-	✓	-	-	-	-	-
Body Awareness	✓	-	-	-	✓	-	-	-	-
Hearing	✓	✓	-	✓	-	-	-	-	-
Planning & Ideas	-	-	-	✓	-	-	-	-	-
Social Participation	-	-	-	-	-	-	✓	-	-
Taste & Smell	-	-	-	-	-	-	✓	-	-
Touch	✓	-	-	-	-	-	-	-	-
Vision	-	✓	-	-	-	-	-	-	-

Note: ✓ indicates significant difference, - indicates no significance

Table 4-22 indicated 66.67% (18 out of the total 27 sensory subscale measures, including total scores) displayed a significant difference for at least one point during either intervention or maintenance phase. Of the eight sensory subscales for each year, five areas had significant difference in 2012 where three areas maintained the change; four areas had significant difference in 2013 with two areas maintained the change; and three areas had significant difference in 2014 with none maintaining the change.

This observation may have some important implications for classroom practice, considering that the intervention was delivered solely by classroom staff with fortnightly consultations with an OT in 2012, by classroom staff with fortnightly consultation following an observation by an OT in 2013, and delivered entirely by student OTs supervised by expert OTs in 2014. Possible explanations for this observation are discussed in Chapter 5.

Comparison of direct observation and SPM data

Direct observations included task engagement, frequency of student-initiated social interactions, and frequency and duration of emotional behaviours. The SPM scores across sensory subscales – balance & motion, body awareness, hearing, planning & ideas, social participation, touch, taste, vision – and by total raw scores of all sensory subscales. It is reasonable that the data from parts of the direct observation should be able to be compared with data from comparable parts of the SPM.

Literature provides links between sensory processing difficulties and behaviours of students (Ashburner, Ziviani and Rodger, 2008; Gal, Dyck and Passmore 2010). This suggests that *p* values for the social participation subscale from the SPM could be compared with student-initiated social interactions data from direct observation.

As noted in Chapter 2, there is neurophysiological involvement of the premotor cortex, visual cortex, and auditory cortex in task engagement (Ciesielski et al., 2006; Danzl et al., 2012; Minshew & Keller, 2010). This suggests that scores from balance & motion, body awareness, hearing, planning & ideas, and vision subscales from the SPM could be compared with task engagement data from direct observation.

Similarly, there are neurophysiological links between the amygdala, hippocampus, prefrontal cortex, and visual cortex with emotional regulation (Diano et al., 2017; Kohn et al., 2014; Samson, Hardan, Podell, et al., 2015; Samson et al., 2014; Swain et al., 2015). Since these neural networks involve the emotion, movement, vision, and other sensory subscales, this suggested that total raw scores from the SPM may be compared with both frequency and duration of emotional behaviours from direct observation.

Comparisons in these three areas are contained in the following sub-sections.

Comparison of direct observation and SPM data for task engagement

Table 4-23 compared direct observation data for task engagement with SPM sensory subscale scores for balance and motion, body awareness, hearing, planning & ideas, and vision. In the table, differences in the SPM scores are reported as “T0-T2” or “T0-T1”, which are shorthand for baseline (T0) to maintenance (T2) or baseline (T0) to post-observation (T1). T0-T2 indicated the effect was sustained, or not, through to maintenance (even if not significant), while T0-T1 indicated there was improvement, or not, during intervention but not sustained to maintenance.

Table 4-23. *Comparison of direct observation and SPM data for task engagement*

	Year		
	2012	**2013**	**2014**
Direct observation	(Randomisation test of significance)		
Task engagement p =	0.17	0.01 *	0.001 *
SPM scores	(Bonferroni post hoc test of significance)		
Balance & Motion p = (phase)	0.03 * (T0-T2)	0.04 * (T0-T2)	0.11 (T0-T2)
Body Awareness p = (phase)	0.03 * (T0-T2)	0.00 * (T0-T2)	0.06 (T0-T2)
Hearing p = (phase)	0.01 * (T0-T2)	0.1 (T0-T2)	0.39 (T0-T2)
Planning & Ideas p = (phase)	0.11 (T0-T2)	0.02 * (T0-T2)	1.00 (T0-T2)
Vision p = (phase)	0.07 (T0-T2)	0.23 (T0-T2)	0.19 (T0-T2)

Note: * indicates significant difference

2012. Direct observation scores for task engagement were not significant (*p* = 0.17). SPM scores for balance & motion (*p* = 0.03) and hearing (*p* = 0.01) had significant difference between baseline and maintenance (T0-T2). Body awareness (*p* = 0.01) and vision (*p* = 0.07) showed significant difference between baseline and intervention (T0-T1) that was not sustained during maintenance (T0-T2 or T1-T2). The planning and ideas scores had no significant difference between baseline and maintenance phase (T0-T2).

2013. Direct observation scores for task engagement were significant (*p* = 0.01). SPM scores for body awareness (*p* = 0.00) and planning & ideas (*p* = 0.02) were significantly different from baseline to maintenance phase (T0-T2). Balance & motion (*p* = 0.01) and hearing (*p* = 0.01) were significant during the intervention phase (T0-T1), but not sustained during maintenance (T0-T2 or T1-T2). Vision subscale scores were not significant from baseline and intervention phase.

2014. Direct observation scores for task engagement were significant (*p* = 0.00). None of the SPM scores for sensory subscales were significant.

This indicated that sensory subscale scores as perceived by the teachers were not sustained once the fidelity to the intervention elements was removed during the maintenance phase, even though the children still had access to the equipment and staff maintained supervision for safety purposes.

Comparison of direct observation and SPM data for social behaviours

Table 4-24 compared direct observation data for task engagement with SPM sensory subscale scores for social participation. In the table, differences in the SPM scores are reported as “T0-T2” or “T0-T1”, which are shorthand for baseline (T0) to maintenance (T2) or baseline (T0) to post-observation (T1). T0-T2 indicated the effect was sustained through to maintenance (even if not significant), while T0-T1 indicates the effect was not sustained to maintenance.

Table 4-24. *Comparison of direct observation and SPM data for social behaviours*

	Year		
	2012	**2013**	**2014**
Direct observation	(Randomisation test of significance)		
Social interactions *p* =	0.19	0.06	0.01 *
SPM scores	(Bonferroni post hoc test of significance)		
Social participation *p* = (phase)	0.06 (T0-T2)	0.28 (T0-T2)	0.20 (T0-T2)

Note: * indicates significant difference

2012. Direct observation scores for social interactions were not significant (*p* = 0.19). SPM scores for social participant were not significant (*p* = 0.06).

2013. Direct observation scores and SPM scores were not significant.

2014. Direct observation scores were significant (*p* = 0.01) as were SPM scores during the intervention phase (T0-T1) (*p* = 0.01), although not sustained during the maintenance phase (T0-T2).

Over the three years, direct observations for student-initiated social interactions and SPM subscale scores for social participation were consistent. Both the direct observations and the SPM scores for social participation indicated that there was no effect as the result of SI intervention.

Comparison of direct observation and SPM data for emotional behaviours

Table 4-25 compared direct observation data for frequency and duration of emotional behaviours with the total scores of SPM sensory subscale scores. In the table, differences in the SPM scores were reported as “T0-T2” or “T0-T1”, which are shorthand for baseline (T0) to maintenance (T2) or baseline (T0) to post-observation (T1). T0-T2 indicated the effect was sustained through to maintenance (even if not significant) while T0-T1 indicated the effect was not sustained to maintenance.

Table 4-25. *Comparison of direct observation and SPM data for emotional behaviours*

	Year		
	2012	**2013**	**2014**
Direct observation	(Randomisation test of significance)		
Frequency of emotional behaviours *p* =	0.93	0.44	0.02 *
Duration of emotional behaviours *p* =	0.14	0.29	0.05 *
SPM scores	(Bonferroni post hoc test of significance)		
Total scores *p* = (phase)	0.04 * (T0-T2)	0.05 * (T0-T2)	0.06 (T0-T2)

Note: * indicates significant difference

2012. Both frequency and duration of emotional behaviours from direct observations were not significantly different. The total score for all sensory subscales was significantly different in 2012 ($p = 0.04$) and was sustained to the maintenance phase (T0-T2).

2013. Both frequency and duration of emotional behaviours from direct observations were not significantly different. The total score for all sensory subscales was significantly different in 2013 ($p = 0.05$) and was sustained to the maintenance phase (T0-T2).

2014. Both frequency ($p = 0.02$) and duration ($p = 0.05$) of emotional behaviours from direct observations were significantly different ($p = 0.05$) during intervention phase (T0-T1), although not sustained to the maintenance phase (T0-T2).

This inconsistency between the results may have various reasons. While the original intent of SPM was only to collect subjective information from people who know the child well, the instrument has a strong evidence of reliability and validity. Thus, the present study compared the two data sets obtained from administration of direct observations and the SPM which indicated inconsistency between their results. First, SPM total scores did not reflect the full range of reasons a child could experience emotional distress that is reflected by direct observations scores. Second, direct observations recorded behaviours as they occurred *during* class time, while the SPM was administered by the teachers *outside* class time. Third, direct observations recorded each behaviour for individuals and then significance was calculated, while SPM Total sensory scores was a group comparison of all sensory subscales for each student. A possible fourth reason may be the presence of OTs in the classroom during the intervention phase. Once the fidelity of the SI intervention elements was withdrawn, so did the effect on behaviours, even though the children still accessed the equipment and activities.

Social validation

Parents of seven participating students were chosen randomly to view video recordings of their children during table tasks (task engagement) and during yard play (social interaction) at both baseline (T0) and post-intervention (T1). Parents viewed the recordings and completed a questionnaire (Appendix B).

Table 4-26 presents the number of times the student was engaged with a task (or task materials), the overall focus on the task, and any comments, for both baseline (T0) and post-observation (intervention) (T1).

Table 4-26. *Parent data for task engagement*

	Baseline (T0)			Post-observation (T1)		
Parent (year)	**Number**	**Focus**	**Comments**	**Number**	**Focus**	**Comments**
1 (2012)	0	Rare	Looked agitated, unhappy, unsettled	6	Some	Interested, happy, willing, engaged, distracted by numbers
2 (2013)	31	Occasional	Seemed anxious and aggressive (touched the screen repeatedly during the task)	40	Some	Distracted but attentive
3 (2013)	7	Rare	Sluggish, distracted	20	Some	Engaged, lacked motivation
4 (2014)	20	Some	Engaged with task, uninterested in teacher	24	Prolonged	Satisfied, interested in task and teacher
5 (2014)	8	Occasional	Engaged, calm, happy	15	Prolonged	Engaged, calm, happy
6 (2014)	7	Occasional	Distracted	29	Prolonged	Engaged
7 (2014)	0	Rare	Agitated, unhappy, unsettled	6	Some	Interested, happy, engaged, willing

When comparing baseline and post-observation data, parents found all students had improved focus on-task and increased task engagement. Comments indicated that parents thought children were engaged with the task longer and with fewer distractions, indicating more focus on task. The comments also indicated a change in the quality of student behaviour, with a change from agitation, distraction, sluggishness, and disinterest to increased engagement, interest, alertness and happiness.

Table 4-27 recorded the number of times the student initiated social interactions, the overall quantity of social interactions, and any comments, for both baseline (T0) and post-observation (intervention) (T1).

Table 4-27. *Parent data for social interaction*

	Baseline (T0)			Post-observation (T1)		
Parent (Year)	**Number**	**Quantity**	**Comments**	**Number**	**Quantity**	**Comments**
1	17	Some	Happy, calm, distracted	36	Frequent	Calm, curious, happy
2	2	None	Sad, upset	4	Rare	Calm
3	3*	None	Calm, sluggish	5*	None	More aware of surroundings, looks at others, but no interactions
4	0	None	Calm, happy	0	None	Calm, happy
5	0	None	Calm, happy	0	None	Calm, happy
6	5	Rare	Upset at times	9	Occasional	Calm, happy
7	4	Rare	Tired, uninterested in play	8	Some	Happy, enjoying himself

Note: * indicates the child looked at other children rather than actually interacting.

When comparing baseline and post-observation data, most parents observed an increased number and overall quantity of interactions, and increases in calmness, awareness of surroundings, and enjoyment. For two children no changes observed by their parents.

Inter-observer agreement (reliability)

In 2012, data were collected by the class teacher, and concurrently by the teaching assistant. In 2013 and 2014, the researcher carried out the simultaneous observations with the classroom teacher as the primary observer. Simultaneous observations were conducted for the 20% of observations as recommended by Kennedy (2004);

Kratochwill and Levin (2014a) during the baseline and intervention phases for task engagement and social interactions. Simultaneous non-observance of behaviour was not counted to avoid inflating the agreement ratio (Kazdin, 1982c).

Tables 4-28, 4-29 and 4-30 summarised inter-observer agreement for task engagement observations made in 2012, 2013 and 2014 respectively. The conventional benchmark of acceptance of inter-observer agreement ratio is 80% (Kennedy, 2004).

Table 4-28. *Inter-observer agreement for task engagement, 2012*

	Observations			
Student	**Agreed (A)**	**Disagreed (D)**	**Total (A+D)**	**Ratio of agreement**
1	138	8	146	94.5%
2	71	6	77	92%
3	158	15	173	91%
4	85	9	94	90%
5	32	6	38	84%
6	112	11	123	91%

Table 4-29. *Inter-observer agreement for task engagement, 2013*

	Observations			
Student	**Agreed (A)**	**Disagreed (D)**	**Total (A+D)**	**Ratio of agreement**
1	147	8	155	95%
2	164	9	173	95%
3	31	8	39	79.5%
4	156	33	189	82.5%
5	138	17	155	89%
6	85	7	93	91%

Table 4-30. *Inter-observer agreement for task engagement, 2014*

	Observations			
Student	**Agreed (A)**	**Disagreed (D)**	**Total (A+D)**	**Ratio of agreement**
1	117	13	130	90%
2	64	8	72	89%
3	79	5	84	94%
4	104	9	113	92%
5	114	20	134	85%
6	118	11	129	91.5%
7	116	7	123	94%
8	115	6	121	95%
9	138	5	143	96.5%
10	84	13	97	87%
11	144	6	150	96%

All but one (79.5%) of the ratios of agreement for 2012 (Table 4-28), 2013 (Table 4-29) and 2014 (Table 4-30) were at least 80%, and indeed fell within the accepted range of 85%-100% (Kennedy, 2004). This indicated that the data collected from direct observations for periods of task engagement within a 10-minute observation while the students were engaged in a tabletop task were reliable.

Tables 4-31, 4-32 and 4-33 summarised inter-observer agreement data for social interactions observations made in 2012, 2013 and 2014 respectively. The conventional benchmark of acceptance of inter-observer agreement ratio is 80% (Kennedy, 2004).

Table 4-31. *Inter-observer agreement for social interactions, 2012*

	Observations			
Student	**Agreed (A)**	**Disagreed (D)**	**Total (A+D)**	**Ratio of agreement**
1	25	3	28	89%
2	0	0	0	100%
3	5	0	5	100%
4	33	6	39	85%
5	3	0	3	100%
6	66	8	74	89%

Table 4-32. *Inter-observer agreement for social interactions, 2013*

	Observations			
Student	**Agreed (A)**	**Disagreed (D)**	**Total (A+D)**	**Ratio of agreement**
1	25	2	27	92.5%
2	2	0	2	100%
3	45	13	58	78%
4	2	0	2	100%
5	4	0	4	100%
6	27	4	31	87%

Table 4-33. *Inter-observer agreement for social interactions, 2013*

	Observations			
Student	**Agreed (A)**	**Disagreed (D)**	**Total (A+D)**	**Ratio of agreement**
1	3	2	5	60.00%
2	3	1	4	75.00%
3	13	3	16	81.25%
4	10	3	13	76.92%
5	2	1	3	66.67%
6	13	4	17	76.47%
7	21	2	23	91.30%
8	29	7	36	80.56%
9	19	1	20	95.00%
10	2	1	3	66.67%
11	9	3	12	75.00%

In 2012 the ratios fell in the range 85% to 100% (Table 4-31), in 2013 the ratios fell in the range of 77% to 100% (Table 4-32) and in 2014 60% to 95% (Table 4-33). While 80% agreement is conventionally acceptable, a lower figure of agreement is considered useful and acceptable depending on the conditions where the participant displays infrequent occurrence of the target behaviour (Kazdin, 1982c). The point-by-point method of calculating agreement takes into account the agreement and disagreement of the observed behaviours by both observers. In this case, low agreement ratio was observed with a low number of student-initiated social interactions, and the ratio improved with the higher number of interactions, which might have been influenced by individual motivation.

As mentioned in Chapter 3, inter-observer agreement could not be calculated for frequency and duration of emotional behaviours due to administrative reasons.

Fidelity measure checklist (fidelity) data

Data for the fidelity study were produced by OTs completing the Fidelity Measure checklist. Table 4-34 summarises responses to the fidelity measure.

Table 4-34. *Fidelity measure checklist responses*

	2012	2013	2014
OTs	1	1	2
Classroom:			
Structural elements (2 items)	50%	100%	100%
Components of pre-assessment (3 items)	40%	40%	40%
Physical environment (12 items)	84%	92%	92%
Communication with parents (2 items)	50%	100%	100%
Intervention process elements (10 items)	90%	90%	100%
Gym:			
Structural elements (2 items)	50%	100%	100%
Components of pre-assessment (3 items)	40%	40%	40%
Physical environment (12 items)	100%	100%	59%
Communication with parents (2 items)	50%	100%	100%
Intervention process elements (10 items)	100%	100%	100%

As is evident from Table 4-34, 50%-100% agreement occurred for structural elements, physical environment, communication with parents, and the intervention process elements across the years and both the classroom and the gym.

In 2012, parent communication involved giving initial information and obtaining permission for student participation in the intervention. In 2013 and 2014, with greater involvement of professional OTs, there was increased communication with the parents, as evident in the higher scores for parent communication in 2013 and 2014.

The component of pre-assessment received the lowest scores as the pre-assessment involved included observation of the students in their classroom and gym environment prior to completing the SPM for each participant. This may be due to difficulties in obtaining case histories and prior referrals consistently for each participant.

The low score for physical environment in 2014 was likely due to the OT judgment on having limited flexibility with suspension equipment and bungee ropes when compared to usual clinical environment for OTs. The fidelity data indicated that a high level of fidelity across all elements was maintained in 2014 with close involvement of expert OTs, compared to that in 2012 and 2013 when there was only periodic involvement of expert OTs.

Summary

There were two main data sets in the study, namely, direct observations and the SPM scores for sensory subscales, along with data sets for IOA, social validation and fidelity. The ExPRT (v. 2.1) was administered to analyse the direct observation data. This analysis indicated increased task engagement, and decreased frequency and duration of emotional behaviours when intervention was delivered by expert OTs; whereas no change was observed in student-initiated social interactions regardless of the mode of delivery of SI intervention. SPSS version 23 was used to analyse the SPM sensory subscale scores by employing within-year repeated measures ANOVA. The results indicated that significant changes were observed within six out of nine sensory subscales when teachers delivered the intervention, compared to only three subscales when OTs delivered the intervention. Some of the sensory subscale scores were further compared to the dependent variables based on the literature, namely, task engagement, student-initiated social interactions, frequency and duration of emotional behaviours with consistently no findings for social interactions and inconsistent findings for task engagement and emotional behaviours. The implications of these findings are discussed in the following chapter.

Chapter 5

Discussion

Supporting students with a dual diagnosis of autism and intellectual disability to be ready to learn within a classroom setting is important for ensuring equitable access to educational opportunities. The overarching aim of this thesis was to evaluate whether SI intervention as part of classroom practice for 5 to 6-year-old students in a special school setting was effective in increasing (a) task engagement and (b) initiation of social interactions, and (c) decreasing negative emotional behaviours. Three different groups of children participated in the study over the three years when this study was conducted. This chapter will discuss the results of the analysis of the two data sets, the implications of those findings for practice, limitations of this study and future directions. The discussion will first focus on how the findings of this study compared with the current literature base by paying close attention to methodological issues highlighted by previous studies. The results from this study will then be interpreted in relation to the study of research questions, specifically how SI intervention influences task engagement, social initiation, duration and frequency of emotional behaviours, and sensory processing for children with autism and intellectual disability.

As discussed in the literature review (see chapter 2), SI intervention has been quite controversial. The report by the National Professional Development Centre on ASD (Wong et al., 2015) identified SI intervention as a 'focused intervention practice' that was excluded from the evidence-based practice list for lack of sufficient evidence (Wong et al., 2015). The reasons for exclusion were; insufficient studies undertaken by diverse groups of researchers, lack of a wider participant cohort, and the need for rigorous research designs. The 27 identified EBPs were mostly of social-behavioural nature, with exercise being the only EBP as an intervention involving whole body movement.

The literature reviewed has documented mixed findings regarding the efficacy and effectiveness of SI intervention for students with autism and other disabilities. Earlier literature (1972-1982) indicated that there were some positive gains following SI intervention in psycho-educational measures (i.e., language skills, memory, eye-hand coordination, attention and planning ability and academic skills such as reading, writing, spelling and mathematics) and motor measures (i.e., movement, strength, planning, agility, and so forth) (Ottenbacher, 1982). Positive gains were also reported in sensorimotor skills and motor planning, socialization, attention and behaviour regulation, participation in active play and achievement of individual goals (Vargas & Camilli, 1999). The later reviews (e.g., Brosnan, 2011; Case-Smith, 2008; Case-Smith, 2014; Machalicek, 2007; May-Benson, 2010; Schaaf, 2014; Schaaf, 2018) revealed mixed results.Case-Smith and Arbesman (2008) identified that there was limited evidence for positive changes in behaviours of children; Case-Smith et al. (2014) found positive evidence of SI intervention but there was limited fidelity to intervention elements. Two reviews by Brosnan and Healy (2011) and Machalicek et al. (2007) found that successful interventions addressing challenging behaviours among children with autism and/or developmental disabilities did not necessarily have sensory integration intervention. The others mentioned above found positive outcomes from SI intervention, especially for children with autism without intellectual disability, but recommended a cautionary approach due to the paucity of studies with fidelity of ASI® (Smith Roley et al., 2007).

Reliability measures

The researcher employed three reliability measures to (a) eliminate observer bias and (b) ensure fidelity of intervention. Of these, inter-observer agreement (IOA) aimed to reduce observer bias (Kazdin, 1982c). The calculated agreement ratio for 2013 and 2014 data for task engagement fell in the accepted range of 80 % - 100 % (Kazdin, 1982c).

Validity measures

Social validation was assessed through subjective evaluation to determine whether stakeholders supported the observed changes in behaviours after intervention (Richards et al., 2013a). Social validation was one of the recommended procedures to ensure that the intervention produced the desired effects and possibilities of an observer bias were reduced (Kazdin, 1982b; Richards et al., 2013a). The social validation in this study was provided by seven randomly selected parents of participants. Social validation confirmed that parents found the children more engaged during the table task and more relaxed during yard play after twenty intervention sessions (i.e., after six to seven weeks of SI intervention).

A checklist based on the Fidelity Measure (Parham et al., 2011) was created by the researcher and used to ensure fidelity of the intervention. The Fidelity Measure checklist (Parham et al., 2011) provided a validity measure for the intervention programme, with the process section of the checklist providing reliability and validity checks when OTs trained in the SI intervention scored the measure.

Replication effect

A SCED is considered to have met the standard if the study included at least three attempts to establish intervention effect at three different points in time (Kratochwill et al., 2010; Kratochwill & Levin, 2014b). SCED literature recommended that multiple replications evident in a study demonstrated that the intervention effect was less due to coincidence with greater confidence in the intervention effect (Richards et al., 2013a). A clearly outlined and documented intervention procedure was used to facilitate future replication (see Chapter 3). The multiple baseline research design, too, contributed to producing the replication effect throughout the study and maintained inter-subject reliability (Kratochwill et al., 2010; Richards et al., 2013a). This study demonstrated experimental control by replicating the change only after the intervention had been introduced across the participants. The rigour in this study was provided by this experimental control across participants as observed in the multiple baseline design.

Effect of SI intervention on task engagement

This research question asked whether classroom-based implementation of a SI intervention for children with a dual diagnosis of autism and intellectual disability, aged 5-6 years in their first year of schooling, had a significant impact on duration of task engagement. Task engagement of students with autism reportedly relied on early developmental neural networks where there is greater cerebellar activity, along with increased activity in the visual and auditory systems; that is, SI intervention within two or more sensory systems (Ciesielski et al., 2006; Danzl et al., 2012). Further, task engagement occurred as a result of challenged and engaged neural networks; where the engagement was achieved through active participation, meaningful activities, and deliberate application of effort that was apparent through the action of starting and continuing a task (Danzl et al., 2012). These features can be supported through classroom-based SI intervention. Task engagement involved neural networks of the recognition system that receives sensory inputs and recognise their patterns, the strategic system to plan and execute the action, and the affective system that relies on individual preferences (Pisha & Coyne, 2001). The present study investigated task engagement based on these facts. As reported, Table 4.2 (Chapter 4) demonstrated that across the three years, along with individual differences, an overall large effect size (NAP) was identified for 91.30 % of participants for task engagement. The R-IRD scores also supported improved task engagement for 82.61 % of participants. (Tables 4-3, 4-4, 4-5; Chapter 4).

Effect size (NAP) findings and significant ANOVA findings for Vision in 2012, Body Awareness for 2012 and 2013, and Planning and Ideas for 2013, aligned with improved task engagement. The literature on effects of SI intervention has not investigated task engagement as a dependent variable but used Goal Attainment Scales (Mailloux et al., 2007) as one of the measures (e.g.,Miller, Coll, et al., 2007; Pfeiffer et al., 2011; Schaaf et al., 2014). While the aforementioned studies used specifically developed goals for individual participants by the therapist and parent, they mention only that the goals were broadly from the areas of sensory processing, functional fine motor skills, and social-emotional skills. The present study used a clear and consistent measure of task engagement, with clearly defined target behaviours, but it is difficult to compare the two due to lack of details of the goals from the GAS. While some studies reported significant improvement in Goal

Attainment Scales (e.g.,Miller, Coll, et al., 2007; Pfeiffer et al., 2011; Schaaf et al., 2014; Schaaf & Nightlinger, 2007), as did task engagement from the present study, two studies did not find similar improvement in task-engaged behaviours of participants (Bonggat & Hall, 2010; Watling & Dietz, 2007). Earlier meta-analyses indicated a negligible weighted effect (0.29) in goal attainment (Vargas & Camilli, 1999), especially in comparison to other interventions (0.09) (Leong et al., 2015).

Previous studies examined effect of intervention on individual Goal Attainment Scales (Mailloux et al., 2007), which could not be used for comparison of effect for this study, due to a lack of defined target behaviours. Also, the limitations of previous research (i.e., Miller, 2007; Pfeiffer, 2017; Schaaf, 2014; Schaaf, 2007) made it difficult to assign improvement in task engagement to the implementation of SI intervention; the rigour of this study indicated that task engagement could improve in young students with autism and intellectual disability after participation in the SI intervention for four to five days per week over six or more weeks. The effects for improving task engagement in the present study were moderate to large indicating that the SI intervention had clinically significant benefits that may warrant the time and effort needed for implementation.

Effect of SI intervention on social initiations

This research question asked whether classroom-based implementation of SI intervention for children with a dual diagnosis of autism and intellectual disability, aged 5-6 years in their first year of schooling, had a significant impact on frequency of social initiations during free play opportunities in the school-yard. Social interaction in autism relies on language and communication ability (APA, 2013;

Joseph et al., 2005; Loucas et al., 2008) as well as social motivation, which in turn relates to perceived rewards and anxiety connected to social interaction (Chen et al., 2015; Chevallier et al., 2012; Factor et al., 2016; Ruff & Fehr, 2014). The findings in this study did not indicate improvement in measures of student initiated social interactions from baseline to intervention across the three years. Table 4-6 (Chapter 4) demonstrated that, an overall effect size (NAP) indicated small to negligible effects of SI intervention on student-initiated social interactions for half of the participants across all three years, whereas, R-IRD findings showed small effects for fewer participants (percentage) (see Tables 4-7, 4-8, 4-9, Chapter 4). As observed in task engagement, there were individual differences observed in student-initiated social interactions.

Comparison of effect sizes (NAP) between years showed some interesting results. In 2012, effect sizes (NAP) showed that there was no improvement in social interaction; ANOVA findings for the sensory subscale scores for Social Participation had no significant difference either. In 2013, again, there was no effect on student initiated social interaction observed in effect size (NAP) with only 33.33% of participants showing a small increase in student initiated social interaction and no improvement in ANOVA results. The high number of social interactions in the case of participants 1, 4 and 5 during baseline observations in 2013 were indicative of a highly anxious attachment to staff members in the yard environment and demonstrated a decrease during the intervention, as reported by staff members. In 2014, effect size (NAP) indicated that there was a small to medium increase in the frequency of student initiated social interactions during the intervention phase (T0-T1). The repeated measures ANOVA indicated significant difference for Social

Participation with the Bonferroni tests indicating that the significance was between baseline and post-observation (T0-T1). The within-years and between years effect of SI intervention on student-initiated social interactions as discussed, contradicts findings from the previous literature. Previous studies reported improved social interactions (Linderman & Stewart, 1999; McClure & Holtz-Yotz, 1991; Schaaf et al., 2014).

The studies with positive outcomes for social interactions (e.g., Linderman, 1999; McClure, 1991; Schaaf, 2014) did not specify the particular details for measuring social interaction and the observation periods varied from ten minutes to thirty minutes. The present study used ten minutes of observations during yard play for measures of student-initiated social participation; however, ten minutes may not be an adequate timeframe for a reliable measurement of social participation or initiation of social interactions. Social behaviour during the ten-minute period did not address issues of motivation or anxiety experienced by participants related to social interactions, either with adults or with peers, (Corbett et al., 2014; Geurts et al., 2008; Kim et al., 2015). Inappropriate social behaviour or lack of initiation of interactions is attributed to communication difficulties and language ability in autism (Williams White et al., 2007). The literature informs us that social motivation depends on receiving intrinsic rewards from social interaction (Corbett et al., 2014; Geurts et al., 2008; Kim et al., 2015). Children with autism are often subject to social anxiety and experience fear in social situations affecting their social motivation and ultimately, the quantity and quality of social interactions experienced by them (Chen et al., 2015; Corbett et al., 2014; Factor et al., 2016; Geurts et al., 2008; Kim et al., 2015). Literature has widely documented that children with autism require targeted social skills training and development of communication skills as effective intervention for improving social skills and social interactions, rather than a sensory integration-based programme such as the SI intervention. In the course of this study, communication or language ability were not a direct focus of instruction during the SI intervention; teaching students to interact or initiate social interaction was not explicitly taught to the participants as an integral focus as the students engaged in sensory activities. In the future, it could be seen if enhancing the SI intervention with a focus on initiating interactions has an effect on social initiations. In the present study, improved social interactions that were observed for three participants in 2013 were from children who experienced anxiety every time they were away from familiar adults during yard play, causing them to seek out staff for reassurance.

The limited effect of SI intervention on the initiation of social interaction observed in this study was similar to the findings from previous studies (Dawson, Meltzoff, Osterling, Rinaldi, & Brown, 1998; Swettenham et al., 1998). This limited effect of SI intervention on social interaction in the present study may be due to numerous factors such as observation parameters, duration of observations, exclusion of communication and language ability measure, and observation in only one context; that is, the observations for social interaction took place during yard play which was an unstructured environment. Since social interactions are influenced by language and communication ability along with intrinsic motivation that is fostered by reward mechanism, SI intervention may not be a sufficiently targeted intervention to improve social interactions.

Effect of SI intervention on emotional behaviours

This research question asked whether classroom-based implementation of SI intervention for children with a dual diagnosis of autism and intellectual disability, aged 5-6 years in their first year of schooling, had a significant impact on frequency and duration of emotional behaviours in a routine day at school. Literature informs us of the link between fear and anxiety with emotional regulation (Marin & Milad, 2016; White et al., 2014). Transitions, communication difficulties, attention shifting and inhibiting response to stimuli causes an emotional response and may result in persevering behaviours or cause emotional behaviours (Roberts et al., 2017; Rogers & Ozonoff, 2005). The neural networks implicated in this emotional mechanism are the connectivity and activation within different regions of the prefrontal cortex and the amygdala (Diano et al., 2017; Kohn et al., 2014; Mazefsky et al., 2014; Phillips et al., 2008). Changes in the activation patterns that decrease connectivity between the amygdala and regions of the prefrontal cortex along with posterior cingulate and posterior visual cortices result in increased emotional regulation response (Uchida et al., 2015). In practice, programmes such as cognitive behaviour therapy or the Alert programme based on cognitive intervention and a sensory diet have proved effective with teaching adaptive forms of emotional regulation by bringing about a change in the neural networks (Samson, Wells, et al., 2015; Uchida et al., 2015; Wells, Chasnoff, Schmidt, Telford, & Schwartz, 2012). It may be important to investigate whether emotional regulation could be improved by other forms of intervention. The underlying principle of SI was that the intervention changed the child's central nervous system through implementation of specialist activities described in the method section (Chapter 3), thus influencing emotional behaviour (Ayres, 1972).

Emotional regulation in the context of this study constituted a decrease in the frequency and cumulative duration of emotional behaviours (dysregulation). This section discusses the two measures together as two dimensions of the same observed behaviour. Emotional dysregulation leads to challenging behaviours such as aggression, injury to others or self, crying, withdrawal or property damage, and are often addressed through various behavioural interventions (Heyvaert et al., 2014; Horner et al., 2002; Lewis & Sugai, 1999).

There were no Bonferroni post hoc tests of significance directly for emotional behaviours, hence the Total scores for all sensory subscales were utilised for comparison. It was also noted that the SPM Main classroom Form (Miller Kuhaneck et al., 2007) was never intended to be used as a measure for emotional regulation or emotional behaviours, though it is recognised that difficulties with sensory processing and/or modulation may cause disruptive behaviours that may be indicative of emotional dysregulation. Again, while there were individual variations in the findings of the present study, the randomisation test for significance indicated that there was an overall improvement in emotional behaviours qualified by a decrease in the frequency and duration of emotional behaviours for 73.9 % (17 out of 23 of the participants). The findings demonstrated an overall decrease in frequency of emotional behaviours and duration of emotional behaviours (see Chapter 4). Findings from the R-IRD scores indicated some variation with small to medium effects for decrease in the frequency of emotional behaviours compared to the medium decrease in the cumulative duration of emotional behaviours. These results were similar to reduction of challenging behaviours reported by Devlin and colleagues (2011), Pfeiffer and colleagues (2011), reduction of self-injurious behaviour (Devlin et al., 2009;

Larrington, 1987; McClure & Holtz-Yotz, 1991), reduced self-stimulatory behaviours (Fertel-Daly et al., 2001; Smith et al., 2005) and reduced distractive behaviours (Linderman & Stewart, 1999). Contradicting these results were two studies that reported no change in behaviours in response to SI intervention (Reichow et al., 2009; Watling & Dietz, 2007).

The results indicated that the participants experiencing reduced frequency also experienced decreased duration of emotional behaviours. In a few instances the decreased duration of emotional behaviours was experienced even when there was a small increase in the frequency, such as students 2 and 3 (2012), student 6 (2013) and for student 10 (2014). As reported earlier, emotional regulation is achieved when activation in amygdala decreases with a simultaneous increase in activation within the prefrontal cortical region. Factors influencing this change are yet to be explained. The role of serotonin and oxytocin secretion in reward mechanisms, as well as in emotional regulation is well established in the literature (Corbett et al., 2014; Kanat et al., 2014; Neuhaus et al., 2010; Rubenstein & Merzenich, 2003; Ruff & Fehr, 2014). These hormones act as neurotransmitters influencing the limbic region, amygdala and hippocampus, which is the emotional centre of the human brain (Farhud, Malmir, & Khanahmadi, 2014). Thus, when an individual perceives something as a reward, these neurotransmitters are secreted, in turn influencing emotional regulation. This might explain the reason why some participants experienced decreased frequency and duration of emotional behaviours and others did not. The independent variable under investigation was the SI intervention; hence, other changes occurring on a neurological level were outside the scope of this study. However, the secretion of neuro-transmitters or the selectivity of their secretion within some individuals could be a variable to be examined in future.

Presently, cognitive behaviour therapy and Positive Behaviour Intervention and Support (PBIS) are widely used to address challenging behaviours preceded by the Functional Behaviour Assessment (FBA). PBIS employs analysis of environments, and behaviour data to plan an effective intervention (Bradshaw, Koth, Thornton, & Leaf, 2009; Bradshaw, Waasdorp, & Leaf, 2012). SI intervention involved specialised environments and focused on physical activities. It was beyond the scope of this study to directly investigate whether there was a change in the neural networks involved in emotional behaviours. However, this study did indicate some positive outcomes through a decrease in the frequency and duration of emotional behaviours. More investigation may inform how and why the SI intervention influenced the decrease of emotional behaviours among some participants (73.9 %) and not in others (26.1 %).

Relationship between direct observations and SPM scores

The research question asked whether there was any relationship between the outcomes of SI intervention for task engagement, student-initiated social interactions and frequency and duration of emotional behaviours and for sensory processing abilities such as balance & motion, body awareness, hearing, planning & ideas, social participation, touch, taste, and vision. It must be noted here that the SPM does not primarily measure emotional behaviours; it provides a measure of sensory subscale scores that may contribute to emotional behaviours. Another factor of interest in this study was the comparison between the findings from direct observations and the SPM sensory scores. An overall summary of direct observations indicated moderate to large effects in one target behaviour in 2012 when teachers delivered the SI intervention; two target behaviours in 2013 when the teacher received some guidance by a professional OT; and all four target behaviours in 2014 (see Table 4-1, Chapter 4) when the programme was delivered by professional OTs. There was a corresponding significant difference observed for the same target behaviours in years 2013 and 2014. This observation indicated the importance of the fidelity of the SI intervention (Parham et al., 2007; Parham et al., 2011). Conversely, the summary of SPM sensory scores indicated a significant improvement in 66.69% (6 out of 9 sensory scores) in 2012, 55.55% (5 out of 9 sensory scores) in 2013 and only 33.33% (3 out of 9 sensory scores) in 2014 (see Table 22, Chapter 4). Thus, while target behaviours improved during professional supervision in 2014, improvement in the sensory scores on the SPM (Miller Kuhaneck et al., 2007) were the lowest. This difference questioned the objectivity of the person administering and scoring the SPM; the pilot of this study (Phatak, 2012) indicated there were differences in sensory scores of the same participant when the scorer was the teacher or a paraprofessional such as the teaching assistant. To offset this issue of reliability, only teachers did the scoring of the SPM in this study. However, the teachers involved in this study may have had different levels of understanding of sensory processing and resulting behaviours, raising a challenge with reliability of the SPM, as the teachers were the primary recorders of the sensory subscale scores on the SPM and the direct observations. This also raised an issue of training or awareness of teachers before they scored the students while administering the SPM. The data gathered by the SPM was subjective in nature based on the teacher's knowledge of the child and cannot be considered clinical, which may explain the differences in recording the sensory subscale scores.

The SPM has reported a high reliability by consistently scoring a child's behaviours in each sensory modality. However, this study has presented evidence that scoring may be influenced by (a) scorer's understanding and interpretation of observed behaviour and (b) the nature of interaction between the scorer and the child may impact on how they score the child's behaviour for each sensory modality. Thus, while the SPM may help to give a broad understanding of scoring bands denoting 'no difficulty or normal', 'some difficulty' and 'definite difficulty', it may be less reliable for research purposes or may not be sensitive enough to measure small changes following intervention; thus, this tool did not provide the diagnostic rigor of the traditional battery of tests applied by expert occupational therapists. Further, the SPM sensory subscale scores were analysed at a group level, not at individual level, thus influencing the results. Future studies may examine results by matching individual SPM data with direct observation data.

Efficacy of SI intervention

Efficacy of the SI intervention under examination will be discussed first by the observed improvement in the dependent variables, followed by a discussion of participants who did not show improvement. The overall results of this study indicated increased task engagement, limited increase in student-initiated social interactions, and a moderate improvement of emotional regulation (i.e., decrease in frequency and duration of emotional behaviours). However, it would be beneficial to review the participants who did not indicate improvement after the SI intervention.

This study resulted with the highest change in task engagement, followed by the frequency and duration of emotional behaviours. Student-initiated social interactions had the least change and no effect. Task engagement had a large effect size, while the frequency and duration of emotional behaviours had a small to moderate effect. This study was conducted over three years and involved two to three school terms each year. This was a large investment timewise, and a maturation effect for the participants over the extended intervention period may be perceived as a threat to its external validity; especially, as children with intellectual disability need a longer time for skill mastery compared to age matched neuro-typical peers. These results need to be examined for the efficiency of the intervention programme. The longitudinal study involved significant funding of equipment, investment in staff training, prolonged staff engagement and provision of external occupational therapy supervisory staff. This level of resourcing may not be sustainable for schools that do not offer internal school-based therapy services. The extents to which the benefits outweigh the costs require further consideration.

It has been documented that sensory integration based occupational therapy is one of the most sought after interventions, with 37 %- 39 % of families choosing it for their children, next to speech therapy and visual schedules (Green et al., 2006; Hess et al., 2008). However, the limited evidence of the effectiveness of sensory integration intervention has prompted recommendations of a cautious approach (Leong et al., 2015; May-Benson & Koomar, 2010; Wong et al., 2015). The high cost in equipment and training involved in this intervention programme compared to the limited evidence requires consideration for alternative delivery models.

The improvement may have been related to factors incorporated into the SI intervention such as the trust established between the participants with the concerned staff member and the resulting close interactions during the activities. Literature informs that a close relationship and intensive joint participation in activities does have positive effects on behaviours of individuals with autism (Caldwell, 2005; Gutstein & Sheely, 2002). Other aspects of the intervention that may have assisted the improved outcomes might be: (a) the quality of interaction with a skilled therapist, (b) the explicit organisation of the child's attention for specific tasks, (c) the stability of having familiar repeated activities and (d) reinforcing consequences of certain behaviours, independent of the particulars of the sensory experience (Rogers & Ozonoff, 2005). This could explain the fact that out of the fourteen significant sensory subscale scores from the SPM, only five sensory domain scores were found to be significantly different (see Table 4-26, Chapter 4), between baseline and maintenance phase (T0-T2). Conversely, nine sensory domain scores were found to be significantly different between baseline and post-observation phase (T0–T1); where the longer duration of the intervention phase allowed the fostering of closer interactions between participants and staff. However, between 2012, 2013 and 2014 there was only one significantly different sensory subscale score between post-observation to maintenance (T1-T2). In future, a longer exposure to SI intervention may be investigated to see whether a longer intervention influenced participant behaviours.

The reported improvement in three out of four target behaviours (i.e., task engagement, and frequency and duration of emotional behaviours) may be attributed to the physical workout the participants received through participation in the activities of the SI intervention. As reported previously (see Chapter 2), exercise is identified as one of the established EBPs, while sensory integration is reported as an intervention that required more research by different groups employing rigorous research design with adequate replication (Odom et al., 2010). In addition, the effect of exercise on the secretion of neurotransmitters, thereby, on behaviour is also well-documented (Meeusen & De Meirleir, 1995; Van Praag, Kempermann, & Gage, 2000). Exercise is supposed to increase a neuro-plastic response, which is activity dependent, and becomes evident as changed behaviour. Neurotransmitters such as norepinephrine, dopamine and serotonin, released after exercise, are involved in sensory motor integration and motor control (Meeusen & De Meirleir, 1995). Whereas, no biomarkers indicating the presence of cortisone or any neurotransmitters were involved in this study; hence, any observed gains could not be confirmed as caused by increased neuroplasticity.

According to Leong et al. (2015), mixed findings regarding the benefits of SI may be due to variability in methodologies between studies, in particular, differences in interpretation of sensory integration and article selection criteria such as the presence of control group or comparison with other interventions. This meta-analysis made several recommendations to improve methodological standards such as employing a rigorous research design, clearly defined dependent variables, instilling reliability checks and random assignment of participants to intervention, with opportunity for replication (Kratochwill et al., 2010; Richards et al., 2013b).

The present study addressed several of the above-mentioned recommendations. First, the present study evaluated the effects of classroom-based SI intervention for five to six year-old students with a diagnosis of autism and intellectual disability on measures of duration of task engagement, frequency of student initiated social interactions, and the frequency and duration of emotional behaviours. All participants exhibited varying degrees of challenging behaviours. Second, all participants received the SI intervention in a randomly staggered manner. Third, the researcher clearly defined and documented functional dependent variables at the start of the study (see Chapter 3). Fourth, measurement tools were developed and trialled before the start of direct observations. Fifth, this study implemented three types of reliability and validity measures: inter-observer agreement (discussed in Chapter 3), social validation (discussed in Chapter 3) and a fidelity checklist (discussed in Chapter 3) for the SI intervention. The present study met the standards for rigorous SCED and hence adds further to the body of evidence for evaluating SI intervention as a potential EBP (Kratochwill & Levin, 2014b; Leong et al., 2015; Odom et al., 2010; Wong et al., 2015).

Since sensory integration theory was first proposed (Ayres, 1972), it has been debated often. While the earliest systematic reviews of studies supported sensory integration theory (Ottenbacher, 1982; Vargas & Camilli, 1999), subsequent studies yielded mixed results, until the latest systematic review which has categorically rejected the claims made by sensory integration theory (Leong et al., 2015). Further reviews of ASI® intervention have since provided stronger evidence of the efficacy of SI intervention (Schaaf et al., 2018; Schoen et al., 2019; Smith Roley et al., 2007). Keeping this in mind, the researcher started with a null hypothesis that there would be no change in target behaviours of participants due to the sensory integration intervention.

As discussed above, the current study addressed the gap in literature highlighted by the NPDC report (Wong et al., 2015) by engaging a single case experimental multiple baseline design to evaluate the impact of SI intervention for 5-6 year old students with concomitant autism and intellectual disability. The present study investigated the effect of a SI intervention on the periods of task engagement, the frequency of student-initiated social interaction and emotional dysregulation denoted by the frequency and cumulative duration of emotional behaviours of the participants in a routine day at school. Data from direct observations and SPM scores were analysed separately and in unison throughout Chapter 4 and discussed in this chapter to inform classroom practice as well as policy around staffing and professional learning in regards to SI intervention for students with autism. As discussed earlier, this study addressed the methodological issues identified by recent literature (Leong et al., 2015; Odom et al., 2010; Wong et al., 2015) to answer the research questions as follows.

The report on EBPs (Odom et al., 2010) and the meta-analysis by Leong et al. (2015) recommended a cautious approach adopted towards SI intervention. In accordance, the present study used a SCED multiple baseline design combined with a comparison of pre, post, and maintenance scores of sensory domains to investigate the effects of the SI intervention, with data collected from 5-6 year old participants just beginning their formal schooling. This study used a fidelity checklist for the SI intervention, and inter-observer agreement with social validation to ensure reliability and validity of data.

Implications for practice

The findings from this study indicated that task engagement in the classroom could be increased and emotional behaviours in the classroom could be decreased following participation in the SI intervention, especially when the delivery was several times a week (i.e., four to five days each week) over nine weeks or more. In current practice, OTs typically deliver SI intervention therapy under clinical conditions, away from the classroom. This study indicated the benefits of SI intervention within a classroom for three different foundation level classes across three different years, where delivery of intervention was guided by student behaviour which was a result of facing daily challenges within a classroom situation. With the requirement for equitable opportunities in education for students with disability in Australia, there is a need for a paradigm shift regarding autism intervention such as moving away from popular interventions to evidence based intervention practices (AITSL; DECD, 2017; Disability Discrimination Act, 2005; Ruddock, 2005). Hence, the need is for consideration towards the inclusion of class-based approaches that include a focus on sensory integration as a mechanism to support task engagement and potentially the reduction in the frequency and duration of emotional behaviours. Several factors require careful consideration for this to occur.

Professional learning

Generally when teachers encounter challenging behaviours in the classroom, behavioural interventions are often employed as a corrective measure, especially if the teacher is not cognisant of PBIS practices (Bradshaw et al., 2009; Bradshaw et al., 2012). In a typical classroom, the teachers become aware that something is amiss when an incident has occurred. The perception is that teaching children with autism and related behavioural difficulties requires highly specialised training and certain teacher disposition (Bazyk et al., 2009; Busby et al., 2012; K. & Dunlap, 2001). Misunderstanding that behavioural difficulties, at times and for some students, may be linked to sensory processing challenges can result in less effective behavioural approaches being engaged as a corrective measure (Greimel et al., 2010; Lombardo et al., 2010; McPartland, Webb, et al., 2011; McPartland, Wu, et al., 2011; Monk et al., 2010; Neuhaus et al., 2010; O'Donnell, Deitz, Kartin, Nalty, & Dawson, 2012; Piggot et al., 2009; Vivanti et al., 2013).

Understanding the difference between neurological processing in typical children and children with autism would inform teacher practice. Existing neuroscience literature details the highly individualistic processing of auditory, visual, proprioceptive, vestibular, tactile, olfactory and taste sensory subscales in the case of children with autism and intellectual disability (Bauman & Kemper, 2005; Catani et al., 2016; Henderson et al., 2002; Leekam et al., 2007; Loh et al., 2007; McAlonan et al., 2004; Vargas et al., 2005). The impact of this unique neurological pattern of sensory processing in autism and its effect on behaviour is also evident in the scientific literature (Corbett et al., 2014; Greimel et al., 2012; Greimel et al., 2010; Kleinhans, Müller, et al., 2008; Kleinhans, Richards, et al., 2008; McPartland, Webb, et al., 2011; McPartland, Wu, et al., 2011; Snijders et al., 2013). Students with autism exhibit highly individualistic characteristics in task engagement, self-initiated social interactions and emotional behaviours due to these unique patterns (Ciesielski et al., 2006; Danzl et al., 2012; Diano et al., 2017; Joseph et al., 2005; Kohn et al., 2014; Loucas et al., 2008; Odriozola et al., 2016). A child struggling to stay focused on task, or fidgeting in their seat may be offered movement based activities to help them to settle down. Children who find fine motor skills difficult to master could be helped with vestibular activities that involve eye-hand coordination such as throwing quoits while swinging, or activities that involve propelling themselves with the use of a scooter board that improve the upper body strength and muscle tone.

Equipped with the knowledge and understanding of sensory processing, teachers would be able to proactively note the triggers and guide the student into a stabilising activity before the challenge becomes overwhelming; and link this knowledge of sensory processing to other areas of difficulty so that they know what strategies to use and when. As an example, when a teacher noticed disengagement of a student in the class, the teacher could investigate the cause of disengagement, whether the student had lost their place in the lesson (attention, shifting focus), had not comprehended the instruction (auditory processing), or did not know how to begin the task (executive functioning). Possession of knowledge about sensory processing in students with autism may assist the teacher to perceive that student behaviours such as not beginning or completing the given task as originating from a possible challenge with working memory or long-term memory dysfunction, difficulty in auditory processing or difficulty in praxis, rather than being oppositional defiant or 'naughty' (Bazyk et al., 2009; Campbell et al., 2012; Missiuna et al., 2012; Villeneuve & Shulha, 2012). After identifying the difficulty, the teacher could organise appropriate adjustments and accommodations such as providing keywords, a checklist of tasks to be completed or step-by-step instructions to commence the task, work through the steps and subsequently complete the task.

Student behaviours such as constantly fidgeting or moving, hitting other children, banging objects, or making noises, may direct the teacher equipped with sensory processing knowledge to plan an appropriate intervention to divert and redirect the distracting behaviours, rather than imposing punitive measures such as warnings or time-out. An insight into teacher perceptions indicated that the teacher training programmes need to be less segregated and more inclusive to prepare future teachers with knowledge of sensory processing in autism, the difference between sensory processing of typical children and children with autism, and possible interventions

(Boyer & Lee, 2001; Busby et al., 2012; Robertson et al., 2003). Additionally, the teachers indicated that they may need more field experience in special education settings, be supported with evidence based practices, assisted to select the appropriate practice and to conduct behavioural assessment following data collection processes (Boyer & Lee, 2001; Busby et al., 2012; Robertson et al., 2003).

Currently, over forty universities in Australia offer educational neuroscience courses, where the focus is usually on the complex processes underpinning memory, speech and language, thinking and learning. While these courses give some basic understanding of the topic, they do not provide a complete understanding of the ways and the degree to which disability disrupts these processes and interferes with learning. This lack of knowledge influences teacher perspective of student disengagement or student behaviour as oppositional, distractive, unmotivated, obsessive or wilful. In addition to the need of specialist knowledge, literature has also identified the need for guided field experiences, collection and assessment of behavioural data, planning and implementing interventions as necessary to augment teacher training (Boyer & Lee, 2001; Busby et al., 2012; Robinson, 2017). Hence, education systems may require a creative and flexible approach towards professional learning for teachers that incorporates understanding of the sensory challenges experienced by students with autism, their specific needs and possible EBPs to support them.

There may be a possibility of a two-prong approach, with inclusion of neurological processes in various disabilities and their impact on student learning in teacher preparation programmes. There is a further possibility of inter-professional training within university programs (i.e., allied health sciences teaching into some pre-service and post-graduate education courses) and vice versa. The second approach would be to target continued professional learning of experienced teachers. Teacher practice in South Australia has adopted the professional standards prescribed by the Australian Institute for Teaching and School Leadership (AITSL). The first professional standard recommends that teachers know their students and how they learn through (i) physical, social and intellectual development and characteristics of students, (ii) understand how students learn, (iii) students with diverse linguistic, cultural and socio-economic backgrounds, (iv) strategies to teach aboriginal and Torres Strait islander students, (v) differentiate teaching students with different abilities and skills, (vi) strategies to support students with disabilities. Thus, continued professional learning could extend teachers' understanding of how neurological processes influence different styles of learning.

The sixth professional standard recommends engaging in professional learning by (i) identifying and planning professional learning needs, (ii) engaging in professional learning and improving practice, (iii) engaging with colleagues and improving practice, and (iv) applying the professional learning to improve student learning. Experienced teachers could continue to develop their knowledge of neurological or sensory processes involved in learning and use it to inform their practice. The literature has indicated that this professional development could take the form of focused training by expert occupational therapists during the school holidays, in-class coaching by therapists, formation of peer support groups and peer mentoring (Boyer & Lee, 2001; Busby et al., 2012; Robertson et al., 2003).This model was used by the participating special school in this study. The staff received some sessions of after hour training by OTs, followed by continued classroom consultations. The staff also organised themselves for continued support through forming a professional learning community. The Queensland Department of Education implemented a similar collaboration model with the speech pathologist-educator integrative programme (Department of Education, 2012). Another initiative of collaborative practice between OT services and educators was the OT for Kids programme (OT for Kids) (Hutton, 2009). Such high quality inter-professional networks may provide the cross-over of knowledge, skills and expertise through training, mentoring and instructional coaching.

Staffing and equipment

During the present study, the school funded a specially equipped gym and a sensory room along with specialised equipment in the classroom. Implementation of the SI intervention also needed release time for teachers to receive training in the application of the programme. A full-time person, a teacher's aide employed with the school, was in charge of setting up and maintenance of equipment in the gym. The teacher's aide consulted with the supervising OT to understand what was needed to set up the gym before the sessions. Engaging OTs trained in the sensory integration methodology to supervise the programme incurred additional cost. This contributed to the costs borne by the school through its programme funding and fundraising activities. However, this model could not be sustained in the long term by individual schools. Such specialised training models require implementation at a systemic level. A system-wide support would need development of a policy statement, appropriate approvals, and allocation of funds at state level as demonstrated by other collaborative models discussed in Chapter 2 (Department of Education, 2012; Hutton, 2009; Missiuna et al., 2012; Sayers, 2008; Villeneuve & Shulha, 2012). This gives rise to several questions: what systemic specialist resources are currently available to teachers; what action research can inform the implementation of collaborative models such as discussed earlier; how can specialist training be enhanced for special education teachers? Does this mean that funding occupational therapists for special schools, classes and units be supported by the education system? With limited evidence, a cautious approach is needed before committing significant funding. Hence, as suggested by Leong et al., (2015), SI intervention must gather more empirical evidence.

Policy

Lastly, to set up a comprehensive intervention programme, there should be a professional OT on site or be accessible to support the school as required. As this study indicated, the results improved when expert OTs delivered the SI intervention. Traditional occupational therapy targets skills such as adaptive skills, motor coordination, and visual-spatial skills as well as SI intervention. In the current scenario, the public school sector in South Australia does not offer occupational therapy for students at school. Parents of children who are challenged by the above mentioned skill areas seek private therapy in a clinical setting which is now being funded through the National Disability Insurance Scheme (NDIS). The transference of such therapeutic intervention to classroom is not automatic. In most cases, therapy and classroom practice are secluded, whereas, some of the therapeutic activities may be successfully integrated into classroom practice, as demonstrated by the current study. In recent times, the National Disability Insurance Agency implementing the NDIS has played a main role in assessing the child’s need and providing the funds necessary to implement therapeutic programmes (NDIA, 2017), though this practice remains exclusive due to individual funding for children. There is no collaboration of OTs with the school staff. However, it is often noted that parents prefer for their child to receive therapy during time at school, which is an opportunity for collaboration (Missiuna et al., 2012; Sayers, 2008; Villeneuve & Shulha, 2012). The South Australian context demonstrated that delivery of therapy during school hours needed formulation of a policy in terms of supervision and Duty of Care (DECD, 2016, 2017). The policy from the Department may further formalise collaborative practice of OTs in schools under a scheme such as NDIS to better support the students within their everyday learning environment and support parents around organisation of delivery of the therapy.

At present, there are no occupational therapists employed by public schools in South Australia at present. However, the National Disability Insurance Scheme (NDIS) has ensured that there are more children than ever before, accessing therapy services in and out of school hours. In many instances, parent preference is for the therapy to be administered onsite with the school's permission (DECD, 2016). There is an opportunity for a dialogue between the therapist, teacher and the parent about the specific challenges the child experiences at school. The therapy goals could focus on developing skills to address the challenges in the classroom or in the wider school environment, which are also transferrable to the home and community settings. Currently, these consultations are more incidental than structured in nature. It would benefit the child, parents and the educators if they happened on a regular basis in a pre-determined manner with common goals to work towards (Missiuna et al., 2012; Sayers, 2008; Villeneuve & Shulha, 2012). For instance, a child who had difficulty with handwriting may also have difficulty involving fine motor tasks such as eating with cutlery at home and in the community. A child who had difficulty transitioning between learning areas may also have difficulty transitioning between different activities at home and in the community. Sensory sensitivities involving touch, smells, and sounds may cause difficulty for the child at school, home as well as in the community. Hence, a therapist that collaborated with parents and teachers could support the child's skills, abilities, attention, memory, and learning as a holistic experience. This type of collaboration between therapists and educators offer a possible transdisciplinary model of intervention in future (Campbell et al., 2012; Department of Education, 2012; Hutton, 2009; Missiuna et al., 2012). The capacity building aspect of such a collaboration would enable the teachers to identify the frustration and difficulties experienced by the children sooner than later, and be able to deliver appropriate accommodations and adaptive strategies before resulting in academic, physical and mental frustration (Campbell et al., 2012; Missiuna et al., 2012).

There are a few more possibilities to explore to support making such a commitment of incorporating specialist interventions such as SI intervention in special school settings. There has been a previous pull-out model for school based occupational therapy with limited success (Missiuna et al., 2012; Sayers, 2008). As discussed in Chapter 2, this model has changed to more collaborative models, namely, Partnering for Change (P4C) (Campbell et al., 2012; Missiuna et al., 2012) and Occupational Therapy into Schools (OTiS) (Hutton, 2009). The P4C model had a focus on capacity building, collaboration and coaching instead of 'curing' or 'fixing' the student's difficulties; the OTiS model was based on the therapist being situated directly in a school and providing learning intervention activities alongside the teachers for the whole group. These models have reported successful outcomes for teachers who felt more supported and felt more confident in being able to identify difficulties among students, find an appropriate adaptive strategy or make a suitable accommodation before the child developed secondary challenges that interfered with their engagement and learning (Campbell et al., 2012; Missiuna et al., 2012). The OTiS model also reported that the students, teachers and paraprofessionals were at risk of losing interest as the programme became ‘stagnant’.

However, the success of these models in Canada and UK has encouraged development of similar collaborative models in Scotland and New Zealand (Campbell et al., 2012; Missiuna et al., 2012). In the local South Australian educational context, a comparable pilot project could be set up in collaboration with the Occupational Therapy programmes at universities, where the graduating students may complete their professional experience component with special schools, special classes, and disability units under the expert supervision of their tutors. This was a model adopted by the participating special school in 2014 for this study.

Two occupational therapists in charge of the practical component of the university programme supervised the graduating occupational therapy students in their practicum placement. The OT students administered initial assessment of participating students, planned individual activity programmes and later implemented the intervention under their supervisors and class teachers. The supervising OTs guided the teachers to add certain learning activities for their students in the classroom and the teachers in turn supported the participation of their students in the intervention programme. This collaboration proved successful with the teachers and paraprofessionals feeling supported and the graduating occupational students getting adequate field experience under expert supervision.

The present study employed a longitudinal SCED multiple baseline and repeated measures design with reliability and validity measures such as a replication effect, IOA, social validation and fidelity checklists to strengthen the research. However, the study also had certain limitations that will be discussed as follows.

Limitations

In conjunction with several positive outcomes from this study and associated implications for practice, there were also several limitations that need to be acknowledged and addressed in future research. The researcher focused on 5-6 year old children in a special school who had the dual diagnosis of autism and intellectual disability, where all participants had a reported high level of sensory behaviours associated with autism. This meant the findings from this study could not be generalised for all children with autism, given that not all children have an intellectual disability and the severity of sensory behaviours could be variable for each child. The relatively small number of participants, $n = 23$, was another limitation that prevents generalisation of findings across all children with autism.

While the study was conducted over three years, the mode of delivery was different for each year. Prior to commencement of the study, the participating teacher and the researcher had undergone professional learning on the delivery of SI intervention. Teachers, with a fortnightly consultation with a qualified OT in 2012 undertook implementation of SI intervention, where the OT relied on the teacher’s report of student behaviours. The items on the fidelity measure checklist were marked together by the teacher and researcher for 2012 retrospectively, when the checklist based on the Fidelity Measure (Parham et al., 2011) was developed. In 2013, the OT visited the school, carried out observations in the classroom for the participants and suggested specific activities of the SI intervention for them. This helped the OT to complete the fidelity measure checklist at the end of the programme in 2013. Expert OTs closely supervised the implementation of SI intervention in 2014 and had the highest level of fidelity. The varying nature of the fidelity of SI intervention may have influenced the different year-wise findings for each year cohort in the study. Analysis of the fidelity checklist indicated a 90 % - 100 % adherence to the programme requirements with highest fidelity for physical environment, parent communication, and programme process. Pre-assessment of participants was the lowest scoring element on the fidelity checklist as the application of the detailed battery of tests in a school environment was difficult. Structural elements, such as professional training of individuals in charge of programme delivery, scored low in 2012, but were high in 2013 and 2014 with the involvement of trained OTs.

One of the main limitations was the high level of dysfunction denoted by very high sensory scores on the SPM for the 2012 cohort, compared to the cohort in 2013 and 2014. The high level of challenging behaviours among the participants in 2012 was a confounding variable in this study. The pilot for this study in 2011 had outlined that the nature of the interaction between participant and the scorer (for example, teacher) influenced the marking of scores. While the teacher’s main interactions with the participants were around task engagement and social behaviours, the paraprofessional’s interactions were around personal care and social behaviours. Thus, for the present study, individual class teachers alone administered the SPM and marked scores. Inter-observer reliability was ensured for the direct observation data in this study, but not for administering the SPM. This may have left the SPM open to subjectivity by the scorer, depending on individual's knowledge and experience of sensory processing and related behaviours.

The calculated IOA for social interactions fell in the lower range at 60 % - 100 %; this range is acceptable according to Kazdin (1982c), as social interactions were infrequent behaviours for most of the participants. Another reason for the lower IOA range may have been the added challenge of tracking the participants across a large outdoor play area. The distance at which the primary observer and reliability observer stood from the participants may have caused them to miss some interactions. The agreement ratios for task engagement and social interactions were within acceptable range and met one requirement of IOA as a reliability measure in this study.

This study relied on direct observations of target behaviours and sensory scores from the SPM. It did not make use of *f*MRI scans, pulse rate monitoring, body temperature, cortisol levels in saliva or electrical resistance response of skin as biomarkers. While *f*MRI scanning may be an expensive measure to implement, collecting saliva samples and monitoring of pulse rate and temperature is relatively inexpensive. Literature has provided evidence of cortisol in saliva, a faster than normal pulse rate and the difference in body temperature as a response to stress. In the absence of such biomarkers, it is not clear if the positive outcomes of this study were the genuine effects of the SI intervention or other influences (Caldwell, 2005; Gutstein & Sheely, 2002; Odom et al., 2010). Neurophysiology related to task engagement and emotional regulation, using medical imagining, would provide interesting verification as to the effect of SI intervention; however, the ability to measure this in real-life classroom contexts needs further consideration in terms of practical application.

Recommendations for the future

The results of the present study have extended existing information about the efficacy and efficiency of a SI intervention. However, there are several recommendations for further research. They are: (i) Further studies to be conducted by diverse researchers (e.g., from different backgrounds), incorporating the robust methodological recommendations by Leong et al. (2016) (ii) Future studies into SI intervention should examine its implementation in the classroom context, across different year levels such as Early Years Centres, rather than clinical contexts alone (iii) Additional studies using randomised controlled trials or studies employing an alternating treatments design will provide a more robust comparison of the effects of two or more interventions (iv) Use biometric measures in addition to behavioural observations for definitive conclusions (v) This research would be further informed by studying the effects of the SI intervention on older groups of students, students with autism but without co-existing intellectual disability, adolescents with autism, or younger children as early intervention.

Conclusion

This study was conducted at a special school where school placement is determined by diagnoses of autism with intellectual disability. This study indicated some gains in task engagement and decrease in frequency and duration of emotional behaviours with no effect observed on student initiated social interactions for 5 – 6-year-old students diagnosed with autism, intellectual disability and high sensory needs. It is also important to note that previous systematic literature reviews and meta-analyses of the effects of SI intervention have investigated the same limited number of studies, which possessed several design-related challenges along with challenges around inclusion criteria. Since SI intervention is the only intervention that targets sensory processing difficulties, which now feature in the diagnostic criteria for autism; it requires further investigation with larger participant groups. Randomised control trials comparing effects of SI intervention with other treatments and sufficient replication of effect would be beneficial. Introduction of biomarkers such as pulse rate or cortisol levels in saliva at pre, post and during intervention over the study, or examining of *f*MRI scans pre and post-intervention would clearly identify physiological effects of SI intervention on individual students. This study also identified the need for professional training and/or mentoring of teachers to understand that challenging behaviours maybe due to specific sensory needs and relevant interventions to address them. Finally, the study identified the need of school-based expert OTs to support teachers and students.

References

Ahn, R. R., Miller, L. J., Milberger, S., & McIntosh, D. N. (2004). Prevalence of parents' perceptions of sensory processing disorders among kindergarten children. *American Journal of Occupational Therapy, 58*(3), 287-293.

AITSL. Australian Institute for Teaching and School Leadership (Website). Retrieved from https://www.aitsl.edu.au/teach/standards. Retrieved 22/10/2017 https://www.aitsl.edu.au/teach/standards

Allen, G., & Courchesne, E. (2003). Differential effects of developmental cerebellar abnormality on cognitive and motor functions in the cerebellum: an fMRI study of autism. *American Journal of Psychiatry, 160*(2), 262-273.

Alliant International University. (2014). Alliant International University Dissertation/Doctoral Projectstyle And Format Manual. In A. I. University (Ed.). USA.

American Psychiatric Association. (2013). *Diagnostic and Statistical Manual of Mental Disorders (DSM-5®)* (5th ed.). Washington, DC: American Psychiatric Pub.

Anzalone, M. E., & Murray, E. A. (2002). Integrating sensory integration with other approaches to intervention. In A. C. Bundy, S. J. Lane, & E. A. Murray (Eds.), *Sensory integration: Theory and practice* (2nd ed ed., pp. 371-391). Philadelphia: F. A. Davis and Company.

APA. (2013). *Diagnostic and Statistiical Manual of Mental Disorders* (5 ed.). Washington DC: American Psychiatric Association.

ASHA, A. S.-L.-H. A. (1996). Central auditory processing: Current status of research and implications for clinical practice.

Ashburner, J., Rodger, S. A., Ziviani, J. M., & Hinder, E. A. (2014). Optimizing participation of children with autism spectrum disorder experiencing sensory challenges: A clinical reasoning framework Optimiser la participation des enfants atteints d'un trouble du spectre autistique ayant des troubles sensoriels: Un cadre pour le raisonnement clinique. *Canadian Journal of Occupational Therapy, 81*(1), 29-38.

Ashburner, J., Ziviani, J., & Rodger, S. (2008). Sensory processing and classroom emotional, behavioral, and educational outcomes in children with autism spectrum disorder. *American Journal of Occupational Therapy, 62*(5), 564-573.

Assaf, M., Hyatt, C. J., Wong, C. G., Johnson, M. R., Schultz, R. T., Hendler, T., & Pearlson, G. D. (2013). Mentalizing and motivation neural function during social interactions in autism spectrum disorders. *NeuroImage: Clinical, 3*, 321-331.

Australian Bureau of Statistics. (2009). *Autism in Australia*. Canberra Retrieved from http://www.abs.gov.au/ausstats/abs@.nsf/Previousproducts/4428.0Main%20Features92009?opendocument&tabname=Summary&prodno=4428.0&issue=2009&num=&view=

Australian Bureau of Statistics. (2014, 04/06/2014). Autism in Australia, 2012. Retrieved from http://www.abs.gov.au/ausstats/abs@.nsf/Latestproducts/4428.0Main%20Features32012?opendocument&tabname=Summary&prodno=4428.0&issue=2012&num=&view=

Australian Bureau of Statistics. (2015) Autism in Australia. In, *Disability, Ageing and Carers, Australia: Summary of Findings*. Canberra: Australian Bureau of Statistics.

Axelrod, R. (1973). Schema theory: An information processing model of perception and cognition. *American political science review, 67*(4), 1248-1266.

Ayres, J. (1972). Sensory integration and learning disorders. In *Sensory integration and child*: Western Psychological Services.

Ayres, J. (1976). *Southern California sensory integration tests*: Western Psychological Services.

Ayres, J. (1978). Learning disabilities and the vestibular system. *Journal of Learning Disabilities, 11*(1), 30-41.

Ayres, J. (1980). The nervous system within: Understanding how the brain works and the importance of sensation. In *Sensory integration and the child* (25th Anniversary edition ed., pp. 28): Pediatric Therapy Network.

Ayres, J. (1989). Sensory integration and praxis tests (SIPT). *Los Angeles: Western Psychological Services*.

Ayres, J., & Tickle, L. S. (1980). Hyper-responsivity to touch and vestibular stimuli as a predictor of positive response to sensory integration procedures by autistic children. *American Journal of Occupational Therapy, 34*(6), 375-381.

Baer, D. M., Wolf, M. M., & Risley, T. R. (1968). Some current dimensions of applied behavior analysis. *Journal of Applied Behavior Analysis, 1*(1), 91-97. doi:10.1901/jaba.1968.1-91

Bahrami, F., Movahedi, A., Marandi, S. M., & Abedi, A. (2012). Kata techniques training consistently decreases stereotypy in children with autism spectrum disorder. *Research in Developmental Disabilities, 33*(4), 1183-1193. doi:https://doi.org/10.1016/j.ridd.2012.01.018

Baker, A. E., Lane, A., Angley, M. T., & Young, R. L. (2008). The relationship between sensory processing patterns and behavioural responsiveness in autistic disorder: A pilot study. *Journal of Autism and Developmental Disorders, 38*(5), 867-875.

Bandura, A. (1977). Social learning theory Englewood Cliffs. In: NJ: Prentice-Hall.

Barbeau, E. B., Lewis, J. D., Doyon, J., Benali, H., Zeffiro, T. A., & Mottron, L. (2015). A greater involvement of posterior brain areas in interhemispheric transfer in autism: fMRI, DWI and behavioral evidences. *NeuroImage: Clinical, 8*, 267-280. doi:http://dx.doi.org/10.1016/j.nicl.2015.04.019

Baron-Cohen, S. (1990). Autism: A Specific Cognitive Disorder of & lsquo; Mind-Blindness'. *International Review of Psychiatry, 2*(1), 81-90.

Baron-Cohen, S. (1997). *Mindblindness: An essay on autism and theory of mind*: MIT press.

Baron-Cohen, S., Ashwin, E., Ashwin, C., Tavassoli, T., & Chakrabarti, B. (2009). Talent in autism: hyper-systemizing, hyper-attention to detail and sensory hypersensitivity. *Philosophical Transactions of the Royal Society of London B: Biological Sciences, 364*(1522), 1377-1383.

Baron-Cohen, S., Jolliffe, T., Mortimore, C., & Robertson, M. (1997). Another advanced test of theory of mind: Evidence from very high functioning adults with autism or Asperger syndrome. *Journal of Child Psychology and Psychiatry, 38*(7), 813-822.

Baron-Cohen, S., Leslie, A. M., & Frith, U. (1985). Does the autistic child have a "theory of mind"? *Cognition, 21*(1), 37-46.

Barrasso-Catanzaro, C., & Eslinger, P. J. (2016). Neurobiological Bases of Executive Function and Social-Emotional Development: Typical and Atypical Brain Changes. *Family Relations, 65*(1), 108-119. doi:10.1111/fare.12175

Barton, E. E. (Producer). (2015, 22/01/2018). Non-overlap methods in single-case research methodology. *Single-Case Intervention Research Design and Analysis*. [Power point presentation] Retrieved from https://slideplayer.com/slide/7072892/

Barton, E. E., Reichow, B., Schnitz, A., Smith, I. C., & Sherlock, D. (2015). A systematic review of sensory-based treatments for children with disabilities. *Research in Developmental Disabilities, 37*, 64-80.

Bauman, M. L., & Kemper, T. L. (2005). Neuroanatomic observations of the brain in autism: a review and future directions. *International Journal of Developmental Neuroscience, 23*(2), 183-187. doi:https://doi.org/10.1016/j.ijdevneu.2004.09.006

Bazyk, S., Michaud, P., Goodman, G., Papp, P., Hawkins, E., & Welch, M. A. (2009). Integrating occupational therapy services in a kindergarten curriculum: A look at the outcomes. *American Journal of Occupational Therapy, 63*(2), 160-171.

Beeson, P. M., & Robey, R. R. (2006). Evaluating Single-Subject Treatment Research: Lessons Learned from the Aphasia Literature. *Neuropsychology review, 16*(4), 161-169. doi:10.1007/s11065-006-9013-7

Belmonte, M. K., Cook, E., Anderson, G. M., Rubenstein, J. L., Greenough, W. T., Beckel-Mitchener, A., . . . Levitt, P. R. (2004). Autism as a disorder of neural information processing: directions for research and targets for therapy. *Molecular Psychiatry, 9*(7), 646-663.

Belmonte, M. K., & Yurgelun-Todd, D. A. (2003). Functional anatomy of impaired selective attention and compensatory processing in autism. *Cognitive Brain Research, 17*(3), 651-664.

Ben-Sasson, A., Hen, L., Fluss, R., Cermak, S. A., Engel-Yeger, B., & Gal, E. (2009). A meta-analysis of sensory modulation symptoms in individuals with autism spectrum disorders. *Journal of Autism and Developmental Disorders, 39*(1), 1-11.

Bernhardt, B. C., Valk, S. L., Silani, G., Bird, G., Frith, U., & Singer, T. (2014). Selective disruption of sociocognitive structural brain networks in autism and alexithymia. *Cerebral Cortex, 24*(12), 3258-3267.

Berryer, M. H., Hamdan, F. F., Klitten, L. L., Møller, R. S., Carmant, L., Schwartzentruber, J., . . . Neugnot-Cerioli, M. (2013). Mutations in SYNGAP1 cause intellectual disability, autism, and a specific form of epilepsy by inducing haploinsufficiency. *Human mutation, 34*(2), 385-394.

Bertone, A., Mottron, L., Jelenic, P., & Faubert, J. (2005). Enhanced and diminished visuo-spatial information processing in autism depends on stimulus complexity. *Brain, 128*(10), 2430-2441.

Blakemore, S.-J., Tavassoli, T., Calò, S., Thomas, R. M., Catmur, C., Frith, U., & Haggard, P. (2006). Tactile sensitivity in Asperger syndrome. *Brain and cognition, 61*(1), 5-13.

Bonett, D. G. (2002). Sample size requirements for estimating intraclass correlations with desired precision. *Statistics in medicine, 21*(9), 1331-1335.

Bonggat, P. W., & Hall, L. J. (2010). Evaluation of the effects of sensory integration-based intervention by a preschool special education teacher. *Education and Training in Autism and Developmental Disabilities*, 294-302.

Bonnel, A., Mottron, L., Peretz, I., Trudel, M., Gallun, E., & Bonnel, A.-M. (2003). Enhanced pitch sensitivity in individuals with autism: A signal detection analysis. *Journal of cognitive neuroscience, 15*(2), 226-235.

Borthwick-Duffy, S. A. (1996). Evaluation and measurement of quality of life: Special considerations for persons with mental retardation. *Quality of life, 1*, 105-119.

Boutot, E. A. (2007). Fitting in: Tips for promoting acceptance and friendships for students with autism spectrum disorders in inclusive classrooms. *Intervention in School and Clinic*, *42*(3), 156-161.

Bouvet, L., Simard-Meilleur, A.-A., Paignon, A., Mottron, L., & Donnadieu, S. (2014). Auditory local bias and reduced global interference in autism. *Cognition, 131*(3), 367-372. doi:http://dx.doi.org/10.1016/j.cognition.2014.02.006

Boyer, L., & Lee, C. (2001). Converting Challenge to Success:Supporting a New Teacher of Students with Autism. *The Journal of Special Education, 35*(2), 75-83. doi:10.1177/002246690103500202

Bradshaw, C. P., Koth, C. W., Thornton, L. A., & Leaf, P. J. (2009). Altering school climate through school-wide positive behavioral interventions and supports: Findings from a group-randomized effectiveness trial. *Prevention science, 10*(2), 100.

Bradshaw, C. P., Waasdorp, T. E., & Leaf, P. J. (2012). Effects of school-wide positive behavioral interventions and supports on child behavior problems. *Pediatrics, 130*(5), e1136-e1145.

Brainwaves. (2016). Your brain and what it does. In B. M. Muscle (Ed.), *http://www.brainwaves.com/index.html*: Allen D. Bragdon Publishers, Inc.

Brian, J., Tipper, S., Weaver, B., & Bryson, S. (2003). Inhibitory mechanisms in autism spectrum disorders: Typical selective inhibition of location versus facilitated perceptual processing. *Journal of Child Psychology and Psychiatry, 44*(4), 552-560.

Brieber, S., Herpertz-Dahlmann, B., Fink, G. R., Kamp-Becker, I., Remschmidt, H., & Konrad, K. (2010). Coherent motion processing in autism spectrum disorder (ASD): An fMRI study. *Neuropsychologia, 48*(6), 1644-1651. doi:http://dx.doi.org/10.1016/j.neuropsychologia.2010.02.007

Brosnan, J., & Healy, O. (2011). A review of behavioral interventions for the treatment of aggression in individuals with developmental disabilities. *Research in Developmental Disabilities, 32*(2), 437-446. doi:https://doi.org/10.1016/j.ridd.2010.12.023

Brown, N. B. (2008). The relationship between context and sensory processing patterns in children with autism. *1453029*.

Brown, N. B., & Dunn, W. (2010). Relationship between context and sensory processing in children with autism. *American Journal of Occupational Therapy, 64*(3), 474-483.

Brown, T., Morrison, I. C., & Stagnitti, K. (2010). The Reliability of Two Sensory Processing Scales Used with School-Age Children: Comparing the Response Consistency of Mothers, Fathers, and Classroom Teachers Rating the Same Child. *Journal of Occupational Therapy, Schools, & Early Intervention, 3*(4), 331-347.

Bundy, A. C., & Murray, E. A. (2002). Sensory integration: A. Jean Ayers' theory revisited. In A. C. Bundy, S. J. Lane, & E. A. Murray (Eds.), *Sensory integration: Theory and practice* (2 ed., pp. 3-29): FA Davis.

Busby, R., Ingram, R., Bowron, R., Oliver, J., & Lyons, B. (2012). Teaching elementary children with autism: Addressing teacher challenges and preparation needs. *The Rural Educator, 33*(2).

Caldwell, P. (2005). *Finding you finding me: Using intensive interaction to get in touch with people whose severe learning disabilities are combined with autistic spectrum disorder*: Jessica Kingsley Publishers.

Campbell, W. N., Missiuna, C. A., Rivard, L. M., & Pollock, N. A. (2012). "Support for everyone": Experiences of occupational therapists delivering a new model of school-based service. *Canadian Journal of Occupational Therapy, 79*(1), 51-59.

Carré, A., Chevallier, C., Robel, L., Barry, C., Maria, A.-S., Pouga, L., . . . Berthoz, S. (2015). Tracking Social Motivation Systems Deficits: The Affective Neuroscience View of Autism. *Journal of Autism and Developmental Disorders, 45*(10), 3351-3363.

Case-Smith, J. (2002). Effectiveness of school-based occupational therapy intervention on handwriting. *American Journal of Occupational Therapy, 56*(1), 17-25.

Case-Smith, J., & Arbesman, M. (2008). Evidence-based review of interventions for autism used in or of relevance to occupational therapy. *American Journal of Occupational Therapy, 62*(4), 416-429.

Case-Smith, J., & Bryan, T. (1999). The effects of occupational therapy with sensory integration emphasis on preschool-age children with autism. *American Journal of Occupational Therapy, 53*(5), 489-497.

Case-Smith, J., Weaver, L. L., & Fristad, M. A. (2014). A systematic review of sensory processing interventions for children with autism spectrum disorders. *Autism*, 1362361313517762.

Catani, M., Dell'Acqua, F., Budisavljevic, S., Howells, H., de Schotten, M. T., Froudist-Walsh, S., . . . Bullmore, E. T. (2016). Frontal networks in adults with autism spectrum disorder. *Brain, 139*(2), 616-630.

CEC. (2014). Council for Exceptional Children Standards for Evidence-Based Practices in Special Education. Retrieved from https://www.cec.sped.org/~/media/Files/Standards/Evidence%20based%20Practices%20and%20Practice/EBP%20FINAL.pdf

Celiberti, D. A., Bobo, H. E., Kelly, K. S., Harris, S. L., & Handleman, J. S. (1997). The differential and temporal effects of antecedent exercise on the self-stimulatory behavior of a child with autism. *Research in Developmental Disabilities, 18*(2), 139-150.

Cermak, S. A., Curtin, C., & Bandini, L. G. (2010). Food selectivity and sensory sensitivity in children with autism spectrum disorders. *Journal of the American Dietetic Association*, *110*(2), 238-246.

Chang, Y.-S., Owen, J. P., Desai, S. S., Hill, S. S., Arnett, A. B., Harris, J., . . . Mukherjee, P. (2014). Autism and sensory processing disorders: shared white matter disruption in sensory pathways but divergent connectivity in social-emotional pathways. *PLoS ONE, 9*(7), e103038.

Chapparo, C., & Ranka, J. (2006). The PRPP System of Task Analysis: user's training manual. *Research Edition. Sydney: OP Network*.

Chawarska, K., Campbell, D., Chen, L., Shic, F., Klin, A., & Chang, J. (2011). Early generalized overgrowth in boys with autism. *Archives of General Psychiatry, 68*(10), 1021-1031. doi:10.1001/archgenpsychiatry.2011.106

Chen, M., Hyppa-Martin, J. K., Reichle, J. E., & Symons, F. J. (2016). Comparing Single Case Design Overlap-Based Effect Size Metrics From Studies Examining Speech Generating Device Interventions. *American journal on intellectual and developmental disabilities, 121*(3), 169-193.

Chen, Y., Bundy, A. C., Cordier, R., Chien, Y.-L., & Einfeld, S. L. (2015). Motivation for everyday social participation in cognitively able individuals with autism spectrum disorder. *Neuropsychiatric Disease and Treatment, 11*, 2699.

Chen, Y., Rodgers, J., & McConachie, H. (2009). Restricted and repetitive behaviours, sensory processing and cognitive style in children with autism spectrum disorders. *Journal of Autism and Developmental Disorders, 39*(4), 635-642.

Cheng, W., Rolls, E. T., Gu, H., Zhang, J., & Feng, J. (2015). Autism: reduced connectivity between cortical areas involved in face expression, theory of mind, and the sense of self. *Brain, 138*(5), 1382-1393. doi:10.1093/brain/awv051

Cheung, P. P., & Siu, A. M. (2009). A comparison of patterns of sensory processing in children with and without developmental disabilities. *Research in Developmental Disabilities, 30*(6), 1468-1480.

Chevallier, C., Kohls, G., Troiani, V., Brodkin, E. S., & Schultz, R. T. (2012). The social motivation theory of autism. *Trends in Cognitive Sciences, 16*(4), 231-239.

Chiang, H. M. (2008). Expressive communication of children with autism: the use of challenging behaviour. *Journal of Intellectual Disability Research, 52*(11), 966-972.

Christensen, D., Baio, J., Van Naarden Braun, K., Bilder, D., Charles, J., Constantino, J., . . . Yeargin-Allsopp, M. (2016). *Prevalence and Characteristics of Autism Spectrum Disorder Among Children Aged 8 Years — Autism and Developmental Disabilities Monitoring Network, 11 Sites, United States, 2012*. Retrieved from United States:

Ciesielski, K. T., Lesnik, P. G., Savoy, R. L., Grant, E. P., & Ahlfors, S. P. (2006). Developmental neural networks in children performing a Categorical N-Back Task. *NeuroImage, 33*(3), 980-990. doi:http://dx.doi.org/10.1016/j.neuroimage.2006.07.028

Cody, H., Pelphrey, K., & Piven, J. (2002). Structural and functional magnetic resonance imaging of autism. *International Journal of Developmental Neuroscience, 20*(3–5), 421-438. doi:http://dx.doi.org/10.1016/S0736-5748(02)00053-9

Cohen, J. (1988). Statistical power analysis for the behavioural sciences. Hillside. *NJ: Lawrence Earlbaum Associates*.

Cohen, J. (1992). A power primer. *Psychological bulletin, 112*(1), 155.

Collignon, O., Charbonneau, G., Peters, F., Nassim, M., Lassonde, M., Lepore, F., . . . Bertone, A. (2013). Reduced multisensory facilitation in persons with autism. *Cortex, 49*(6), 1704-1710.

Corbett, B. A., Constantine, L. J., Hendren, R., Rocke, D., & Ozonoff, S. (2009). Examining executive functioning in children with autism spectrum disorder, attention deficit hyperactivity disorder and typical development. *Psychiatry Research, 166*(2–3), 210-222. doi:http://dx.doi.org/10.1016/j.psychres.2008.02.005

Corbett, B. A., Swain, D. M., Newsom, C., Wang, L., Song, Y., & Edgerton, D. (2014). Biobehavioral profiles of arousal and social motivation in autism spectrum disorders. *Journal of Child Psychology and Psychiatry, 55*(8), 924-934.

Cornish, E. (1998). A balanced approach towards healthy eating in autism. *Journal of Human Nutrition and Dietetics, 11*(6), 501-509.

Courchesne, E., Campbell, K., & Solso, S. (2011). Brain growth across the life span in autism: Age-specific changes in anatomical pathology. *Brain research, 1380*, 138-145. doi:http://dx.doi.org/10.1016/j.brainres.2010.09.101

Courchesne, E., Lincoln, A. J., Kilman, B. A., & Galambos, R. (1985). Event-related brain potential correlates of the processing of novel visual and auditory information in autism. *Journal of Autism and Developmental Disorders, 15*(1), 55-76.

Courchesne, E., Lincoln, A. J., Yeung-Courchesne, R., Elmasian, R., & Grillon, C. (1989). Pathophysiologic findings in nonretarded autism and receptive developmental language disorder. *Journal of Autism and Developmental Disorders, 19*(1), 1-17.

Craig, A. D. (2003). Interoception: the sense of the physiological condition of the body. *Current Opinion in Neurobiology, 13*(4), 500-505. doi:https://doi.org/10.1016/S0959-4388(03)00090-4

Crane, L., Goddard, L., & Pring, L. (2009). Sensory processing in adults with autism spectrum disorders. *Autism, 13*(3), 215-228.

Creswell, J. (2002). Educational research: Planning, conducting, and evaluating quantitative. In *New Jersey: Upper Saddle River* (3 ed., pp. 328-331).

Creswell, J. (2008). Experimental Designs. In *Educational Research- Planning, Conducting, and Evaluating Quantitative and Qualitative Research* (pp. 321). New Jersey: Pearson Education Inc.

Crosland, K., & Dunlap, G. (2012). Effective strategies for the inclusion of children with autism in general education classrooms. *Behavior Modification, 36*(3), 251-269.

Dakin, S., & Frith, U. (2005). Vagaries of visual perception in autism. *Neuron, 48*(3), 497-507.

Dalton, K. M., Nacewicz, B. M., Johnstone, T., Schaefer, H. S., Gernsbacher, M. A., Goldsmith, H., . . . Davidson, R. J. (2005). Gaze fixation and the neural circuitry of face processing in autism. *Nature neuroscience, 8*(4), 519-526.

Danzl, M. M. P. T. D. P. T. N. C. S., Etter, N. M. M. S. C. C. C. S. L. P., Andreatta, R. D. P., & Kitzman, P. H. P. M. (2012). Facilitating Neurorehabilitation Through Principles of Engagement. *Journal of Allied Health, 41*(1), 35-41. Retrieved from https://search.proquest.com/docview/1347609374?accountid=10910

http://flinders-primo.hosted.exlibrisgroup.com/openurl/61FUL/FUL_SERVICES_PAGE??url_ver=Z39.88-2004&rft_val_fmt=info:ofi/fmt:kev:mtx:journal&genre=article&sid=ProQ:ProQ%3Ahealthcompleteshell&atitle=Facilitating+Neurorehabilitation+Through+Principles+of+Engagement&title=Journal+of+Allied+Health&issn=00907421&date=2012-04-01&volume=41&issue=1&spage=35&au=Danzl%2C+Megan+M%2C+PT%2C+DPT%2C+NCS%3BEtter%2C+Nicole+M%2C+MS%2C+CCC%2FSLP%3BAndreatta%2C+Richard+D%2C+PhD%3BKitzman%2C+Patrick+H%2C+PhD%2C+MSPT&isbn=&jtitle=Journal+of+Allied+Health&btitle=&rft_id=info:eric/22544406&rft_id=info:doi/

Dapretto, M., Davies, M. S., Pfeifer, J. H., Scott, A. A., Sigman, M., Bookheimer, S. Y., & Iacoboni, M. (2006). Understanding emotions in others: mirror neuron dysfunction in children with autism spectrum disorders. *Nature neuroscience, 9*(1), 28-30.

Davies, P. L., & Gavin, W. J. (2007). Validating the diagnosis of sensory processing disorders using EEG technology. *The American Journal of Occupational Therapy, 61*(2), 176.

Dawson, G., Meltzoff, A. N., Osterling, J., Rinaldi, J., & Brown, E. (1998). Children with autism fail to orient to naturally occurring social stimuli. *Journal of Autism and Developmental Disorders, 28*(6), 479-485.

DECD. (2016). *Non-DECD seervice providers in preschools, schools and educational programs procedure*. (15/03408-1). Retrieved from https://myintranet.learnlink.sa.edu.au/library/document-library/controlled-procedures/non_decd_service_providers_in_preschools_schools_and_educational_programs_procedure.pdf

DECD. (2017). Children and Young People with Disability policy. In (pp. 5). Adelaide.

Department of Education, T. a. E. (2012). Priorities in speech language therapy services in schools. 2. Retrieved from http://education.qld.gov.au/studentservices/learning/disability/specialists/slt/docs/priorities-speech-language-therapy-state-schools.pdf

Devlin, S., Healy, O., Leader, G., & Hughes, B. M. (2011). Comparison of Behavioral Intervention and Sensory-Integration Therapy in the Treatment of Challenging Behavior. *Journal of Autism and Developmental Disorders, 41*(10), 1303-1320. doi:10.1007/s10803-010-1149-x

Devlin, S., Leader, G., & Healy, O. (2009). Comparison of behavioral intervention and sensory-integration therapy in the treatment of self-injurious behavior. *Research in*

Autism Spectrum Disorders, 3(1), 223-231. doi:http://dx.doi.org/10.1016/j.rasd.2008.06.004

Diano, M., Tamietto, M., Celeghin, A., Weiskrantz, L., Tatu, M.-K., Bagnis, A., . . . Costa, T. (2017). Dynamic Changes in Amygdala Psychophysiological Connectivity Reveal Distinct Neural Networks for Facial Expressions of Basic Emotions. *Scientific Reports, 7,* 45260.

Diolordi, L., del Balzo, V., Bernabei, P., Vitiello, V., & Donini, L. M. (2014). Eating habits and dietary patterns in children with autism. *Eating and Weight Disorders - Studies on Anorexia, Bulimia and Obesity, 19*(3), 295-301. doi:10.1007/s40519-014-0137-0

Disability Discrimination Act. (2005). *Disability Discrimination Amendment (Education Standards) Act 2005*. (19). Retrieved from https://www.legislation.gov.au/Details/C2005A00019

Dominick, K. C., Davis, N. O., Lainhart, J., Tager-Flusberg, H., & Folstein, S. (2007). Atypical behaviors in children with autism and children with a history of language impairment. *Research in Developmental Disabilities, 28*(2), 145-162.

DuBois, D., Ameis, S. H., Lai, M.-C., Casanova, M. F., & Desarkar, P. (2016). Interoception in Autism Spectrum Disorder: A review. In *International Journal of Developmental Neuroscience* (Vol. 52, pp. 104-111).

Dunn, W. (1997). The impact of sensory processing abilities on the daily lives of young children and their families: A conceptual model. *Infants and young children, 9,* 23-35.

Dunn, W., Myles, B. S., & Orr, S. (2002). Sensory processing issues associated with Asperger syndrome: A preliminary investigation. *American Journal of Occupational Therapy, 56*(1), 97-102.

Durlak, J. A. (2009). How to Select, Calculate, and Interpret Effect Sizes. *Journal of Pediatric Psychology, 34*(9), 917-928. doi:10.1093/jpepsy/jsp004

Emerson, E. (2001). *Challenging behaviour: Analysis and intervention in people with severe intellectual disabilities*: Cambridge University Press.

Eyler, L. T., Pierce, K., & Courchesne, E. (2012). A failure of left temporal cortex to specialize for language is an early emerging and fundamental property of autism. *Brain, 135*(3), 949-960. doi:10.1093/brain/awr364

Factor, R. S., Condy, E. E., Farley, J. P., & Scarpa, A. (2016). Brief Report: Insistence on Sameness, Anxiety, and Social Motivation in Children with Autism Spectrum Disorder. *Journal of Autism and Developmental Disorders*, 1-7.

Farhud, D. D., Malmir, M., & Khanahmadi, M. (2014). Happiness & Health: The Biological Factors-Systematic Review Article. *Iranian Journal of Public Health, 43*(11), 1468.

Fatemi, S. H., Aldinger, K. A., Ashwood, P., Bauman, M. L., Blaha, C. D., Blatt, G. J., . . . Dickson, P. E. (2012). Consensus paper: pathological role of the cerebellum in autism. *The Cerebellum, 11*(3), 777-807.

Fernández-Andrés, M. I., Pastor-Cerezuela, G., Sanz-Cervera, P., & Tárraga-Mínguez, R. (2015). A comparative study of sensory processing in children with and without Autism Spectrum Disorder in the home and classroom environments. *Research in Developmental Disabilities, 38*, 202-212. doi:http://dx.doi.org/10.1016/j.ridd.2014.12.034

Fertel-Daly, D., Bedell, G., & Hinojosa, J. (2001). Effects of a weighted vest on attention to task and self-stimulatory behaviors in preschoolers with pervasive developmental disorders. *American Journal of Occupational Therapy, 55*(6), 629-640.

Field, D., Garland, M., & Williams, K. (2003). Correlates of specific childhood feeding problems. *Journal of paediatrics and child health, 39*(4), 299-304.

Fisher, A., & Jones, K. B. (2009). Occupational therapy intervention process model. In *Perspectives on Human Occupations: Theories Underlying Practice* (pp. 27-286).

Fisher, A., & Murray, E. (1991). Introduction to sensory integration theory. *Sensory integration: Theory and practice*, 3-26.

Fletcher, P. C., Happe, F., Frith, U., Baker, S. C., Dolan, R. J., Frackowiak, R. S., & Frith, C. D. (1995). Other minds in the brain: a functional imaging study of "theory of mind" in story comprehension. *Cognition, 57*(2), 109-128.

Foxe, J. J., Molholm, S., Del Bene, V. A., Frey, H.-P., Russo, N. N., Blanco, D., . . . Ross, L. A. (2013). Severe multisensory speech integration deficits in high-functioning school-aged children with autism spectrum disorder (ASD) and their resolution during early adolescence. *Cerebral Cortex*, bht213.

Frith, U. (1989). Autism: Explaining the enigma.

Frith, U., & Happé, F. (1994). Autism: beyond "theory of mind". *Cognition, 50*(1), 115-132.

Gabler, N. B., Duan, N., Vohra, S., & Kravitz, R. L. (2011). N-of-1 trials in the medical literature: a systematic review. *Medical Care, 49*(8), 761-768.

Gabriels, R. L., Agnew, J. A., Holt, K. D., Shoffner, A., Zhaoxing, P., Ruzzano, S., . . . Mesibov, G. (2012). Pilot study measuring the effects of therapeutic horseback riding on school-age children and adolescents with autism spectrum disorders. *Research in Autism Spectrum Disorders, 6*(2), 578-588. doi:https://doi.org/10.1016/j.rasd.2011.09.007

Gaffrey, M. S., Kleinhans, N. M., Haist, F., Akshoomoff, N., Campbell, A., Courchesne, E., & Müller, R.-A. (2007). A typical participation of visual cortex during word processing in autism: An fMRI study of semantic decision. *Neuropsychologia, 45*(8), 1672-1684.

Gafurov, B. S., & Levin, J. R. (2016). ExPRT (Excel® Package of Randomization Tests): Statistical Analyses of Single-Case Intervention Data version 2.1. In (pp. 1-40).

Gal, E., Dyck, M. J., & Passmore, A. (2010). Relationships between stereotyped movements and sensory processing disorders in children with and without developmental or sensory disorders. *American Journal of Occupational Therapy, 64*(3), 453-461.

Garfinkel, S. N., Tiley, C., O'Keeffe, S., Harrison, N. A., Seth, A. K., & Critchley, H. D. (2016). Discrepancies between dimensions of interoception in autism: Implications for emotion and anxiety. *Biological Psychology, 114*, 117-126. doi:http://dx.doi.org/10.1016/j.biopsycho.2015.12.003

Geurts, H. M., Luman, M., & Van Meel, C. S. (2008). What's in a game: the effect of social motivation on interference control in boys with ADHD and autism spectrum disorders. *Journal of Child Psychology and Psychiatry, 49*(8), 848-857.

Gilotty, L., Kenworthy, L., Sirian, L., Black, D. O., & Wagner, A. E. (2002). Adaptive skills and executive function in autism spectrum disorders. *Child Neuropsychology, 8*(4), 241-248.

Goddard, M. N., Swaab, H., Rombouts, S. A., & van Rijn, S. (2016). Neural systems for social cognition: gray matter volume abnormalities in boys at high genetic risk of autism symptoms, and a comparison with idiopathic autism spectrum disorder. *European archives of psychiatry and clinical neuroscience, 266*(6), 523-531.

Goddard, S. (2002). Brain development. In *Reflexes, learning and behavior: A window into the child's mind*

(2 ed., pp. 50): Fern Ridge Press.

Goodman, G., & Williams, C. M. (2007). Interventions for increasing the academic engagement of students with autism spectrum disorders in inclusive classrooms. *Teaching exceptional children, 39*(6), 53-61.

Green, V. A., Pituch, K. A., Itchon, J., Choi, A., O'Reilly, M., & Sigafoos, J. (2006). Internet survey of treatments used by parents of children with autism. *Research in Developmental Disabilities, 27*(1), 70-84.

Greimel, E., Nehrkorn, B., Fink, G. R., Kukolja, J., Kohls, G., Müller, K., . . . Schulte-Rüther, M. (2012). Neural mechanisms of encoding social and non-social context information in autism spectrum disorder. *Neuropsychologia, 50*(14), 3440-3449. doi:http://dx.doi.org/10.1016/j.neuropsychologia.2012.09.029

Greimel, E., Schulte-Rüther, M., Kircher, T., Kamp-Becker, I., Remschmidt, H., Fink, G. R., . . . Konrad, K. (2010). Neural mechanisms of empathy in adolescents with autism spectrum disorder and their fathers. *NeuroImage, 49*(1), 1055-1065.

Grèzes, J., Wicker, B., Berthoz, S., & De Gelder, B. (2009). A failure to grasp the affective meaning of actions in autism spectrum disorder subjects. *Neuropsychologia, 47*(8), 1816-1825.

Gutstein, S., & Sheely, R. K. (2002). *Relationship development intervention with children, adolescents and adults: Social and emotional development activities for Asperger syndrome, autism, PDD and NLD*: Jessica Kingsley Publishers.

Gyurak, A., Gross, J. J., & Etkin, A. (2011). Explicit and implicit emotion regulation: A dual-process framework. *Cognition and Emotion, 25*(3), 400-412. doi:10.1080/02699931.2010.544160

Hadjikhani, N., Joseph, R. M., Snyder, J., Chabris, C. F., Clark, J., Steele, S., . . . Tager-Flusberg, H. (2004). Activation of the fusiform gyrus when individuals with autism spectrum disorder view faces. *NeuroImage, 22*(3), 1141-1150. doi:http://dx.doi.org/10.1016/j.neuroimage.2004.03.025

Hadjikhani, N., Joseph, R. M., Snyder, J., & Tager-Flusberg, H. (2007). Abnormal activation of the social brain during face perception in autism. *Human brain mapping, 28*(5), 441-449. doi:10.1002/hbm.20283

Hamilton, A. F. d. C. (2013). Reflecting on the mirror neuron system in autism: a systematic review of current theories. *Developmental cognitive neuroscience, 3*, 91-105.

Han, Y. M., Leung, W. W.-m., Wong, C. K., Lam, J. M., Cheung, M.-C., & Chan, A. S. (2011). Lymphocyte subset alterations related to executive function deficits and repetitive stereotyped behavior in autism. *Research in Autism Spectrum Disorders, 5*(1), 486-494.

Happé, F., Booth, R., Charlton, R., & Hughes, C. (2006). Executive function deficits in autism spectrum disorders and attention-deficit/hyperactivity disorder: examining profiles across domains and ages. *Brain and cognition, 61*(1), 25-39.

Happé, F., Frith, U., & Briskman, J. (2001). Exploring the cognitive phenotype of autism: weak "central coherence" in parents and siblings of children with autism: I. Experimental tests. *The Journal of Child Psychology and Psychiatry and Allied Disciplines, 42*(3), 299-307.

Hardan, A. Y., Keshavan, M. S., Sreedhar, S., Vemulapalli, M., & Minshew, N. J. (2006). An MRI Study of Minor Physical Anomalies in Autism. *Journal of Autism and Developmental Disorders, 36*(5), 607-611. doi:10.1007/s10803-006-0103-4

Harms, M. B., Martin, A., & Wallace, G. L. (2010). Facial emotion recognition in autism spectrum disorders: a review of behavioral and neuroimaging studies. *Neuropsychology review, 20*(3), 290-322.

Harper, R. (1999). Reporting of precision of estimates for diagnostic accuracy: a review. *Bmj, 318*(7194), 1322-1323.

Harvey, R. E. (2013). *Occupational Therapists' Perceptions of the Utilization of Sensory Diets in the Treatment of Children with Attention Deficit Hyperactivity Disorder*. D'YOUVILLE COLLEGE,

Hawkins, N. G., Sanson-Fisher, R. W., Shakeshaft, A., D'Este, C., & Green, L. W. (2007). The multiple baseline design for evaluating population-based research. *American journal of preventive medicine, 33*(2), 162-168.

Hazlett, H., Poe, M., Gerig, G., & et al. (2005). Magnetic resonance imaging and head circumference study of brain size in autism: Birth through age 2 years. *Archives of General Psychiatry, 62*(12), 1366-1376. doi:10.1001/archpsyc.62.12.1366

Hazlett, H., Poe, M. D., Gerig, G., & et al. (2011). EArly brain overgrowth in autism associated with an increase in cortical surface area before age 2 years. *Archives of General Psychiatry, 68*(5), 467-476. doi:10.1001/archgenpsychiatry.2011.39

Hazlett, H., Poe, M. D., Lightbody, A. A., Styner, M., MacFall, J. R., Reiss, A. L., & Piven, J. (2012). Trajectories of Early Brain Volume Development in Fragile X Syndrome and Autism. *Journal of the American Academy of Child & Adolescent Psychiatry, 51*(9), 921-933. doi:http://dx.doi.org/10.1016/j.jaac.2012.07.003

Heiss, C. J., Moody, L. N., Crosley, J., & Campbell, E. (2005). Nutrient Intake and Eating Behaviors of Boys With and Without Autism. *Journal of the American Dietetic Association, 105*(8, Supplement), 28. doi:http://dx.doi.org/10.1016/j.jada.2005.05.096

Hellendoorn, A., Langstraat, I., Wijnroks, L., Buitelaar, J. K., van Daalen, E., & Leseman, P. P. M. (2014). The relationship between atypical visual processing and social skills in young children with autism. *Research in Developmental Disabilities, 35*(2), 423-428. doi:http://dx.doi.org/10.1016/j.ridd.2013.11.012

Henderson, A., Pehoski, C., & Murray, E. (2002). Visual-spatial abilities. In A. C. Bundy, A. Lane, & E. A. Murray (Eds.), *Sensory integration: Theory and practice* (2nd ed., pp. 124-140). Philadelphia: F. A. Davies Company.

Hess, K. L., Morrier, M. J., Heflin, L. J., & Ivey, M. L. (2008). Autism treatment survey: Services received by children with autism spectrum disorders in public school classrooms. *Journal of Autism and Developmental Disorders, 38*(5), 961-971.

Heyvaert, M., Saenen, L., Campbell, J. M., Maes, B., & Onghena, P. (2014). Efficacy of behavioral interventions for reducing problem behavior in persons with autism: An updated quantitative synthesis of single-subject research. *Research in Developmental Disabilities*, *35*(10), 2463-2476. doi:http://dx.doi.org/10.1016/j.ridd.2014.06.017

Hill, E. L., & Frith, U. (2003). Understanding autism: insights from mind and brain. *Philos Trans R Soc Lond B Biol Sci*, *358*(1430), 281-289. doi:10.1098/rstb.2002.1209

Hill, J., & Furniss, F. (2006). Patterns of emotional and behavioural disturbance associated with autistic traits in young people with severe intellectual disabilities and challenging behaviours. *Research in Developmental Disabilities, 27*(5), 517-528. doi:https://doi.org/10.1016/j.ridd.2005.07.001

Hilton, C., Wente, L., LaVesser, P., Ito, M., Reed, C., & Herzberg, G. (2007). Relationship between motor skill impairment and severity in children with Asperger syndrome. *Research in Autism Spectrum Disorders*, *1*(4), 339-349.

Hodgson, A. R., Freeston, M. H., Honey, E., & Rodgers, J. (2016). Facing the unknown: intolerance of uncertainty in children with autism spectrum disorder. *Journal of applied research in intellectual disabilities*.

Horner, R., Carr, E. G., Strain, P. S., Todd, A. W., & Reed, H. K. (2002). Problem Behavior Interventions for Young Children with Autism: A Research Synthesis.

Journal of Autism and Developmental Disorders, 32(5), 423-446. doi:10.1023/A:1020593922901

Horner, R., Diemer, S. M., & Brazeau, K. C. (1992). Educational support for students with severe problem behaviors in Oregon: A descriptive analysis from the 1987–1988 school year. *Research and Practice for Persons with Severe Disabilities, 17*(3), 154-169.

Hoyson, M., Jamieson, B., & Strain, P. S. (1984). Individualized Group Instruction of Normally Developing and Autistic-like Children: The LEAP Curriculum Model. *Journal of the Division for Early Childhood, 8*(2), 157-172. doi:10.1177/105381518400800209

Hughes, C., Russell, J., & Robbins, T. W. (1994). Evidence for executive dysfunction in autism. *Neuropsychologia, 32*(4), 477-492.

Humphrey, N., & Lewis, S. (2008). Make me normal' The views and experiences of pupils on the autistic spectrum in mainstream secondary schools. *Autism, 12*(1), 23-46.

Humphry, R. (2002). Young children's occupations: Explicating the dynamics of developmental processes. *American Journal of Occupational Therapy, 56*(2), 171-179.

Hutton, E. (2009). Occupational Therapy in Mainstream Primary Schools: An Evaluation of a Pilot Project. *British Journal of Occupational Therapy, 72*(7), 308-313. doi:10.1177/030802260907200707

Hyde, K. L., Samson, F., Evans, A. C., & Mottron, L. (2010). Neuroanatomical differences in brain areas implicated in perceptual and other core features of autism revealed by cortical thickness analysis and voxel‐based morphometry. *Human brain mapping, 31*(4), 556-566.

Iarocci, G., Rombough, A., Yager, J., Weeks, D. J., & Chua, R. (2010). Visual influences on speech perception in children with autism. *Autism, 14*(4), 305-320.

Irwin, J. R., Tornatore, L. A., Brancazio, L., & Whalen, D. (2011). Can children with autism spectrum disorders “hear” a speaking face? *Child Development*, *82*(5), 1397-1403.

Janzen, J. E. (1996). *Understanding the nature of autism: A practical guide*: Psychological Corporation.

Jemel, B., Mimeault, D., Saint-Amour, D., Hosein, A., & Mottron, L. (2010). VEP contrast sensitivity responses reveal reduced functional segregation of mid and high filters of visual channels in autism. *Journal of Vision, 10*(6), 13-13.

Joseph, R. M., McGrath, L. M., & Tager-Flusberg, H. (2005). Executive Dysfunction and Its Relation to Language Ability in Verbal School-Age Children With Autism. *Developmental Neuropsychology, 27*(3), 361-378. doi:10.1207/s15326942dn2703_4

K., H. J., & Dunlap, G. (2001). Including Children with Autism in General Education Classrooms:A Review of Effective Strategies. *Behavior Modification*, *25*(5), 762-784. doi:10.1177/0145445501255006

Kanat, M., Heinrichs, M., & Domes, G. (2014). Oxytocin and the social brain: Neural mechanisms and perspectives in human research. *Brain research*, *1580*, 160-171. doi:https://doi.org/10.1016/j.brainres.2013.11.003

Kawar, M. (2002). Oculomotor control: An integral part of sensory integration. In S. J. L. A. C. Bundy, & E. A. Murray (Ed.), *Sensory integration: Theory and practice* (2nd edition ed., pp. pp. 353–357). Philadelphia: F.A. Davis & Company.

Kazdin, A. (1982a). Behavioural assessment. In *Single-Case Reasearch Designs: Methods for Clinical and Applied Settings* (pp. 17-46). Oxford: Oxford University Press.

Kazdin, A. (1982b). Data evaluation. In *Single case research designs: Methods for clinical and applied settings* (pp. 230-262): Oxford University Press Inc.

Kazdin, A. (1982c). Interobserver Agreement. In *Single-case Research Designs: Methods for clinical and applied settings* (pp. 48-74). New York: Oxford University Press.

Kazdin, A. (2016). Single case experimental research designs. In K. A.E. (Ed.), *Methodological issues and strategies in clinical research* (pp. 459-483): American Psychological Association.

Kennedy, C. H. (2004). Recent innovations in single case designs. *Journal of Behavioural Education, 13*(4), 209-211.

Kennedy, C. H. (2005). *Single-case designs for educational research*: Prentice Hall.

Kern, J., Trivedi, M. H., Garver, C. R., Grannemann, B. D., Andrews, A. A., Savla, J. S., . . . Schroeder, J. L. (2006). The pattern of sensory processing abnormalities in autism. *Autism, 10*(5), 480-494.

Kern, L., Koegel, R. L., & Dunlap, G. (1984). The influence of vigorous versus mild exercise on autistic stereotyped behaviors. *Journal of Autism and Developmental Disorders, 14*(1), 57-67. doi:10.1007/bf02408555

Kielhofner, G., & Fisher, A. (1991). Mind-brain-body relationships. In *Bundy A, Lane S, Murray, E. Sensory integration theory and practice. Philadelphia: FA Davis Company*.

Kientz, M. A., & Dunn, W. (1997). A comparison of the performance of children with and without autism on the Sensory Profile. *American Journal of Occupational Therapy, 51*(7), 530-537.

Kilroy, E., Aziz-Zadeh, L., & Cermak, S. (2019). Ayres Theories of Autism and Sensory Integration Revisited: What Contemporary Neuroscience Has to Say. *Brain sciences, 9*(3). doi:10.3390/brainsci9030068

Kim, K., Rosenthal, M. Z., Gwaltney, M., Jarrold, W., Hatt, N., McIntyre, N., . . . Mundy, P. (2015). A virtual joy-stick study of emotional responses and social motivation in children with autism spectrum disorder. *Journal of Autism and Developmental Disorders, 45*(12), 3891-3899.

Klein, U., & Nowak, A. J. (1999). Characteristics of patients with autistic disorder (AD) presenting for dental treatment: a survey and chart review. *Special Care in Dentistry, 19*(5), 200-207.

Kleinhans, N. M., Müller, R.-A., Cohen, D. N., & Courchesne, E. (2008). Atypical functional lateralization of language in autism spectrum disorders. *Brain research, 1221*, 115-125. doi:https://doi.org/10.1016/j.brainres.2008.04.080

Kleinhans, N. M., Richards, T., Sterling, L., Stegbauer, K. C., Mahurin, R., Johnson, L. C., . . . Aylward, E. (2008). Abnormal functional connectivity in autism spectrum disorders during face processing. *Brain, 131*(4), 1000-1012.

Knaus, T. A., Silver, A. M., Kennedy, M., Lindgren, K. A., Dominick, K. C., Siegel, J., & Tager-Flusberg, H. (2010). Language laterality in autism spectrum disorder and typical controls: A functional, volumetric, and diffusion tensor MRI study. *Brain and Language, 112*(2), 113-120. doi:https://doi.org/10.1016/j.bandl.2009.11.005

Koegel, L., Matos-Freden, R., Lang, R., & Koegel, R. (2012). Interventions for children with autism spectrum disorders in inclusive school settings. *Cognitive and Behavioral practice, 19*(3), 401-412.

Koegel, R. L., Koegel, L. K., & Surratt, A. (1992). Language intervention and disruptive behavior in preschool children with autism. *Journal of Autism and Developmental Disorders, 22*(2), 141-153.

Kohen-Raz, R., Volkman, F. R., & Cohen, D. J. (1992). Postural control in children with autism. *Journal of Autism and Developmental Disorders, 22*(3), 419-432.

Kohn, N., Eickhoff, S. B., Scheller, M., Laird, A. R., Fox, P. T., & Habel, U. (2014). Neural network of cognitive emotion regulation—an ALE meta-analysis and MACM analysis. *NeuroImage, 87*, 345-355.

Koomar, J., & Bundy, A. C. (1991). Creating direct intervention from theory. In A. C. Bundy, S. J. Lane, & E. A. Murray (Eds.), *Sensory integration: Theory and practice* (2nd ed ed., pp. 261-309). Philadelphia: F. A. Davis and Company.

Kratochwill, T. R., Hitchcock, J., Horner, R., Levin, J. R., Odom, S., Rindskopf, D., & Shadish, W. (2010). Single-case designs technical documentation. *What works clearinghouse*.

Kratochwill, T. R., & Levin, J. R. (2014a). Meta-and statistical analysis of single-case intervention research data: Quantitative gifts and a wish list. *Journal of School Psychology, 52*(2), 231-235.

Kratochwill, T. R., & Levin, J. R. (2014b). *Single-case intervention research: Methodological and statistical advances*: American Psychological Association.

Lai, M.-C., Lombardo, M. V., Auyeung, B., Chakrabarti, B., & Baron-Cohen, S. (2015). Sex/gender differences and autism: setting the scene for future research. *Journal of the American Academy of Child & Adolescent Psychiatry, 54*(1), 11-24.

Lai, M.-C., Lombardo, M. V., Suckling, J., Ruigrok, A. N. V., Chakrabarti, B., Ecker, C., . . . Baron-Cohen, S. (2013). Biological sex affects the neurobiology of autism. *Brain, 136*(9), 2799-2815. doi:10.1093/brain/awt216

Landry, R., & Bryson, S. E. (2004). Impaired disengagement of attention in young children with autism. *Journal of Child Psychology and Psychiatry, 45*(6), 1115-1122.

Lane, Mailloux, Z., Schoen, S., Bundy, A., May-Benson, T. A., Parham, L. D., . . . Schaaf, R. C. (2019). Neural Foundations of Ayres Sensory Integration®. *Brain sciences, 9*(7), 153.

Lane, Young, R. L., Baker, A. E., & Angley, M. T. (2010). Sensory processing subtypes in autism: Association with adaptive behavior. *Journal of Autism and Developmental Disorders, 40*(1), 112-122.

Lane, A. E., Geraghty, M. E., Young, G. S., & Rostorfer, J. L. (2014). Problem eating behaviors in autism spectrum disorder are associated with suboptimal daily nutrient intake and taste/smell sensitivity. *ICAN: Infant, Child, & Adolescent Nutrition*, 1941406414523981.

Lane, S. J., Reynolds, S., & Dumenci, L. (2012). Sensory overresponsivity and anxiety in typically developing children and children with autism and attention deficit hyperactivity disorder: cause or coexistence? *AJOT: American Journal of Occupational Therapy, 66*, 595+. Retrieved from http://go.galegroup.com.ezproxy.flinders.edu.au/ps/i.do?p=EAIM&sw=w&u=flinders&v=2.1&it=r&id=GALE%7CA302296862&asid=4860642289cdc76add26835e4b434cd7

Lang, R., O'Reilly, M., Healy, O., Rispoli, M., Lydon, H., Streusand, W., . . . Lancioni, G. (2012). Sensory integration therapy for autism spectrum disorders: A systematic review. *Research in Autism Spectrum Disorders, 6*(3), 1004-1018.

Larrington, G. G. (1987). A sensory integration based program with a severely retarded/autistic teenager: An occupational therapy case report. *Occupational therapy in health care, 4*(2), 101-117.

Lawson, W. (2013). Sensory connection, interest/attention and gamma synchrony in autism or autism, brain connections and preoccupation. *Medical Hypotheses, 80*(3), 284-288.

Leekam, S. R., Nieto, C., Libby, S. J., Wing, L., & Gould, J. (2007). Describing the Sensory Abnormalities of Children and Adults with Autism. *Journal of Autism and Developmental Disorders, 37*(5), 894-910. doi:10.1007/s10803-006-0218-7

Legislation, S. A. (2004). *Teachers Registration and Standards Act* South Australia: Goernment of South Australia Retrieved from https://www.legislation.sa.gov.au/LZ/C/A/TEACHERS%20REGISTRATION%20AND%20STANDARDS%20ACT%202004/CURRENT/2004.57.AUTH.PDF

Lenroot, R. K., & Giedd, J. N. (2006). Brain development in children and adolescents: insights from anatomical magnetic resonance imaging. *Neuroscience & Biobehavioral Reviews, 30*(6), 718-729.

Leong, H. M., Carter, M., & Stephenson, J. R. (2015). Meta-analysis of research on sensory integration therapy for individuals with developmental and learning disabilities. *Journal of Developmental and Physical Disabilities, 27*(2), 183-206.

Lepistö, T., Kujala, T., Vanhala, R., Alku, P., Huotilainen, M., & Näätänen, R. (2005). The discrimination of and orienting to speech and non-speech sounds in children with autism. *Brain research, 1066*(1), 147-157.

Lepistö, T., Silokallio, S., Nieminen-von Wendt, T., Alku, P., Näätänen, R., & Kujala, T. (2006). Auditory perception and attention as reflected by the brain event-related potentials in children with Asperger syndrome. *Clinical Neurophysiology, 117*(10), 2161-2171. doi:http://dx.doi.org/10.1016/j.clinph.2006.06.709

Levin, J. R., Evmenova, A. S., & Gafurov, B. S. (2014). The single-case data-analysis ExPRT(Excel Package of randomisation Tests). In T. R. Kratochwill & J. R. Levin (Eds.), *Single-case intervention research: Methodological and statistical advances* (1 ed., pp. 185-220): American Psychological Association.

Levin, J. R., Ferron, J. M., & Gafurov, B. S. (2016). Comparison of randomization-test procedures for single-case multiple-baseline designs. *Developmental Neurorehabilitation*, 1-21. doi:10.1080/17518423.2016.1197708

Levin, J. R., Ferron, J. M., & Gafurov, B. S. (2017). Additional comparisons of randomization-test procedures for single-case multiple-baseline designs: Alternative effect types. *Journal of School Psychology, 63*, 13-34. doi:https://doi.org/10.1016/j.jsp.2017.02.003

Lewis, T. J., & Sugai, G. (1999). Effective behavior support: A systems approach to proactive schoolwide management. *Focus on Exceptional Children, 31*(6), 1.

Likert, R. (1932). A technique for the measurement of attitudes. *Archives of psychology*.

Linderman, T. M., & Stewart, K. B. (1999). Sensory integrative–based occupational therapy and functional outcomes in young children with pervasive developmental disorders: A single-subject study. *American Journal of Occupational Therapy, 53*(2), 207-213.

Lindsay, S., Proulx, M., Scott, H., & Thomson, N. (2014). Exploring teachers' strategies for including children with autism spectrum disorder in mainstream classrooms. *International Journal of Inclusive Education, 18*(2), 101-122.

Liss, M., Saulnier, C., Fein, D., & Kinsbourne, M. (2006). Sensory and attention abnormalities in autistic spectrum disorders. *Autism, 10*(2), 155-172.

Lo, J.-L., Lin, T.-Y., Chu, H.-H., Chou, H.-C., Chen, J.-H., Hsu, J., & Huang, P. (2007). Playful tray: adopting Ubicomp and persuasive techniques into play-based occupational therapy for reducing poor eating behavior in young children. *UbiComp 2007: Ubiquitous Computing*, 38-55.

Logan, L. R., Hickman, R. R., Harris, S. R., & Heriza, C. B. (2008). Single‐subject research design: recommendations for levels of evidence and quality rating. *Developmental Medicine & Child Neurology, 50*(2), 99-103.

Loh, A., Soman, T., Brian, J., Bryson, S. E., Roberts, W., Szatmari, P., . . . Zwaigenbaum, L. (2007). Stereotyped Motor Behaviors Associated with Autism in High-risk Infants: A Pilot Videotape Analysis of a Sibling Sample. *Journal of Autism and Developmental Disorders, 37*(1), 25-36. doi:10.1007/s10803-006-0333-5

Lombardo, M. V., Chakrabarti, B., Bullmore, E. T., Sadek, S. A., Pasco, G., Wheelwright, S. J., . . . Baron-Cohen, S. (2010). Atypical neural self-representation in autism. *Brain, 133*(2), 611-624. doi:10.1093/brain/awp306

Loucas, T., Charman, T., Pickles, A., Simonoff, E., Chandler, S., Meldrum, D., & Baird, G. (2008). Autistic symptomatology and language ability in autism spectrum disorder and specific language impairment. *Journal of Child Psychology and Psychiatry, 49*(11), 1184-1192.

Lovaas, O. I. (1987). Behavioral treatment and normal educational and intellectual functioning in young autistic children. *Journal of consulting and clinical psychology, 55*(1), 3.

Loveland, K. A., Bachevalier, J., Pearson, D. A., & Lane, D. M. (2008). Fronto-limbic functioning in children and adolescents with and without autism. *Neuropsychologia, 46*(1), 49-62.

Luna, B., Doll, S. K., Hegedus, S. J., Minshew, N. J., & Sweeney, J. A. (2007). Maturation of executive function in autism. *Biological Psychiatry, 61*(4), 474-481.

Machalicek, W., O'Reilly, M. F., Beretvas, N., Sigafoos, J., & Lancioni, G. E. (2007). A review of interventions to reduce challenging behavior in school settings for students with autism spectrum disorders. *Research in Autism Spectrum Disorders, 1*(3), 229-246. doi:https://doi.org/10.1016/j.rasd.2006.10.005

Macintosh, K., & Dissanayake, C. (2006). Social skills and problem behaviours in school aged children with high-functioning autism and Asperger's disorder. *Journal of Autism and Developmental Disorders, 36*(8), 1065-1076.

Mailloux, Z. (1990). An overview of the sensory integration and praxis tests. *American Journal of Occupational Therapy, 44*(7), 589-594.

Mailloux, Z., May-Benson, T. A., Summers, C. A., Miller, L. J., Brett-Green, B., Burke, J. P., . . . Roley, S. S. (2007). Goal attainment scaling as a measure of meaningful outcomes for children with sensory integration disorders. *American Journal of Occupational Therapy, 61*(2), 254-259.

Mandelbaum, D. E., Stevens, M., Rosenberg, E., Wiznitzer, M., Steinschneider, M., Korey, S. R., . . . Korey, S. R. (2006). Sensorimotor performance in school-age children with autism, developmental language disorder, or low IQ. *Developmental Medicine & Child Neurology, 48*(1), 33-39. doi:10.1017/S0012162206000089

Marco, E. J., Hinkley, L. B., Hill, S. S., & Nagarajan, S. S. (2011a). Sensory processing in autism: a review of neurophysiologic findings. *Pediatric research, 69*, 48R-54R.

Marco, E. J., Hinkley, L. B. N., Hill, S. S., & Nagarajan, S. S. (2011b). Sensory Processing in Autism: A Review of Neurophysiologic Findings. *Pediatric research, 69*, 48R. doi:10.1203/PDR.0b013e3182130c54

Marin, M.-F., & Milad, M. R. (2016). Extending the Examination of the Fear Extinction Network Beyond Anxiety and Fear-Based Disorders: Insight Into Autism Spectrum Disorder. *Biological Psychiatry: Cognitive Neuroscience and Neuroimaging, 1*(4), 302-304. doi:http://dx.doi.org/10.1016/j.bpsc.2016.05.002

Marsh, L. E., & Hamilton, A. F. d. C. (2011). Dissociation of mirroring and mentalising systems in autism. *NeuroImage, 56*(3), 1511-1519.

Matson, J. L., & Jang, J. (2014). Treating aggression in persons with autism spectrum disorders: A review. *Research in Developmental Disabilities, 35*(12), 3386-3391. doi:https://doi.org/10.1016/j.ridd.2014.08.025

Matson, J. L., & Shoemaker, M. (2009). Intellectual disability and its relationship to autism spectrum disorders. *Research in Developmental Disabilities, 30*(6), 1107-1114.

Matson, J. L., Sipes, M., Fodstad, J. C., & Fitzgerald, M. E. (2011). Issues in the Management of Challenging Behaviours of Adults with Autism Spectrum Disorder. *CNS Drugs, 25*(7), 597-606. doi:10.2165/11591700-000000000-00000

May-Benson, T. A., & Koomar, J. A. (2010). Systematic review of the research evidence examining the effectiveness of interventions using a sensory integrative approach for children. *American Journal of Occupational Therapy, 64*(3), 403-414.

Mazefsky, C. A., Borue, X., Day, T. N., & Minshew, N. J. (2014). Emotion Regulation Patterns in Adolescents With High-Functioning Autism Spectrum Disorder: Comparison to Typically Developing Adolescents and Association With Psychiatric Symptoms. *Autism Research, 7*(3), 344-354.

Mazefsky, C. A., Herrington, J., Siegel, M., Scarpa, A., Maddox, B. B., Scahill, L., & White, S. W. (2013). The role of emotion regulation in autism spectrum disorder. *Journal of the American Academy of Child & Adolescent Psychiatry, 52*(7), 679-688.

Mazzone, L., Postorino, V., De Peppo, L., Fatta, L., Lucarelli, V., Reale, L., . . . Vicari, S. (2013). Mood symptoms in children and adolescents with autism spectrum disorders. *Research in Developmental Disabilities, 34*(11), 3699-3708.

McAlonan, G. M., Cheung, V., Cheung, C., Suckling, J., Lam, G. Y., Tai, K., . . . Chua, S. E. (2004). Mapping the brain in autism. A voxel-based MRI study of volumetric differences and intercorrelations in autism. *Brain, 128*(2), 268-276.

McClure, M. K., & Holtz-Yotz, M. (1991). The effects of sensory stimulatory treatment on an autistic child. *American Journal of Occupational Therapy*.

McDougal, J., & Hiralall, A. S. (1998). Bridging Research into Practice to Intervene with Young Aggressive Students in the Public School Setting: Evaluation of the Behavior Consultation Team (BCT) Project.

McKavanagh, R., Buckley, E., & Chance, S. A. (2015). Wider minicolumns in autism: a neural basis for altered processing? *Brain, 138*(7), 2034-2045.

McPartland, J. C., Webb, S. J., Keehn, B., & Dawson, G. (2011). Patterns of Visual Attention to Faces and Objects in Autism Spectrum Disorder. *Journal of Autism and Developmental Disorders, 41*(2), 148-157. doi:10.1007/s10803-010-1033-8

McPartland, J. C., Wu, J., Bailey, C. A., Mayes, L. C., Schultz, R. T., & Klin, A. (2011). Atypical neural specialization for social percepts in autism spectrum disorder. *Social Neuroscience, 6*(5-6), 436-451. doi:10.1080/17470919.2011.586880

Meeusen, R., & De Meirleir, K. (1995). Exercise and brain neurotransmission. *Sports Medicine, 20*(3), 160-188.

Mefford , H. C., Batshaw , M. L., & Hoffman , E. P. (2012). Genomics, Intellectual Disability, and Autism. *New England Journal of Medicine, 366*(8), 733-743. doi:10.1056/NEJMra1114194

Miller Kuhaneck, H., Henry, D., & Glennon, T. (2007). Sensory Processing Measure (SPM): Main classroom and environments forms. *Los Angeles: Western Psychological Services*.

Miller, L. J., Anzalone, M. E., Lane, S. J., Cermak, S. A., & Osten, E. T. (2007). Concept evolution in sensory integration: A proposed nosology for diagnosis. *American Journal of Occupational Therapy, 61*(2), 135-140.

Miller, L. J., Coll, J. R., & Schoen, S. A. (2007). A randomized controlled pilot study of the effectiveness of occupational therapy for children with sensory modulation disorder. *American Journal of Occupational Therapy, 61*(2), 228-238.

Miller, L. J., Schoen, S., Coll, J., Brett-Green, B., & Reale, M. (2005). Final report: Quantitative psychophysiologic examination of sensory processing in children with autism spectrum disorders. *Los Angeles, CA: Cure Autism Now*.

Miller, L. J., Wilbarger, J., & Stackhouse, T. (2002/2007). se of clinical reasoning in occupational therapy: The STEP-SI model of intervention of sensory modulation dysfunction. In A. C. Bundy, S. J. Lane, & E. A. Murray (Eds.), *Sensory Integraion: Theory and Practice* (2nd ed ed., pp. 435-451). Philadelphia: F. A. Davis and Company.

Mills, C., & Chapparo, C. (2016). Use of an In-Class Sensory Activity Schedule for a Student with Autism: Critical Case Study. *Creative Education, 07*(07), 979-989. doi:10.4236/ce.2016.77102

Mills, C., & Chapparo, C. (2017). Use of Perceive, Recall, Plan, Perform Stage Two Cognitive Task Analysis for students with autism and intellectual disability: The impact of a sensory activity schedule. *Journal of Occupational Therapy, Schools, & Early Intervention, 10*(3), 232-253. doi:10.1080/19411243.2017.1335262

Mills, C., Chapparo, C., & Hinitt, J. (2016). The impact of an in-class sensory activity schedule on task performance of children with autism and intellectual disability: A pilot study. *British Journal of Occupational Therapy, 79*(9), 530-539. doi:10.1177/0308022616639989

Minshew, N. J., & Keller, T. A. (2010). "The Nature of Brain Dysfunction in Autism: Functional Brain Imaging Studies". *Current opinion in neurology, 23*(2), 124-130. doi:10.1097/WCO.0b013e32833782d4

Missiuna, C. A., Pollock, N. A., Levac, D. E., Campbell, W. N., Whalen, S. D. S., Bennett, S. M., . . . Russell, D. J. (2012). Partnering for change: An innovative school-based occupational therapy service delivery model for children with developmental coordination disorder. *Canadian Journal of Occupational Therapy, 79*(1), 41-50.

Monk, C. S., Weng, S.-J., Wiggins, J. L., Kurapati, N., Louro, H. M., Carrasco, M., . . . Lord, C. (2010). Neural circuitry of emotional face processing in autism spectrum disorders. *Journal of Psychiatry and Neuroscience, 35*(2), 105-115.

Mottron, L., & Belleville, S. (1993). A study of perceptual analysis in a high-level autistic subject with exceptional graphic abilities. *Brain and cognition, 23*(2), 279-309.

Mottron, L., Belleville, S., Rouleau, G. A., & Collignon, O. (2014). Linking neocortical, cognitive, and genetic variability in autism with alterations of brain plasticity: The Trigger-Threshold-Target model. *Neuroscience & Biobehavioral Reviews, 47*, 735-752. doi:http://dx.doi.org/10.1016/j.neubiorev.2014.07.012

Mottron, L., Dawson, M., Soulières, I., Hubert, B., & Burack, J. (2006). Enhanced Perceptual Functioning in Autism: An Update, and Eight Principles of Autistic Perception. *Journal of Autism and Developmental Disorders, 36*(1), 27-43. doi:10.1007/s10803-005-0040-7

Moucha, R., & Kilgard, M. P. (2006). Cortical plasticity and rehabilitation. *Progress in brain research, 157*, 111-389.

NDIA. (2017). *Public Participants Dashboard 20170930 v1*. Retrieved from: https://www.ndis.gov.au/medias/documents/h42/ha3/8805560582174/national-dashboard-30Sep.pdf

Neuhaus, E., Beauchaine, T. P., & Bernier, R. (2010). Neurobiological correlates of social functioning in autism. *Clinical Psychology Review, 30*(6), 733-748. doi:http://dx.doi.org/10.1016/j.cpr.2010.05.007

Neuman, S. B., & McCormick, S. (1995). *Single-Subject Experimental Research: Applications for Literacy*: ERIC.

Nicholson, H., Kehle, T. J., Bray, M. A., & Heest, J. V. (2011). The effects of antecedent physical activity on the academic engagement of children with autism spectrum disorder. *Psychology in the Schools, 48*(2), 198-213. doi:10.1002/pits.20537

Nielsen, J. A., Zielinski, B. A., Fletcher, P. T., Alexander, A. L., Lange, N., Bigler, E. D., . . . Anderson, J. S. (2014). Abnormal lateralization of functional connectivity between language and default mode regions in autism. *Molecular Autism, 5*(1), 8. doi:10.1186/2040-2392-5-8

Noddings, A. T. (2012). *How educators can use sensory integration techniques in the classroom to improve focus in young children: Perspectives from occupational therapists.* SAINT LOUIS UNIVERSITY,

O'Donnell, S., Deitz, J., Kartin, D., Nalty, T., & Dawson, G. (2012). Sensory Processing, Problem Behavior, Adaptive Behavior, and Cognition in Preschool Children With Autism Spectrum Disorders. *The American Journal of Occupational Therapy, 66*(5), 586-594. Retrieved from http://search.proquest.com/docview/1221536393?accountid=10910

http://flinders-primo.hosted.exlibrisgroup.com/openurl/61FUL/FUL_SERVICES_PAGE??url_ver=Z39.88-2004&rft_val_fmt=info:ofi/fmt:kev:mtx:journal&genre=article&sid=ProQ:ProQ%3A

healthcompleteshell&atitle=Sensory+Processing%2C+Problem+Behavior%2C+Adaptive+Behavior%2C+and+Cognition+in+Preschool+Children+With+Autism+Spectrum+Disorders&title=The+American+Journal+of+Occupational+Therapy&issn=02729490&date=2012-09-01&volume=66&issue=5&spage=586&au=O%27Donnell%2C+Shelley%3BDeitz%2C+Jean%3BKartin%2C+Deborah%3BNalty%2C+Theresa%3BDawson%2C+Geraldine&isbn=&jtitle=The+American+Journal+of+Occupational+Therapy&btitle=&rft_id=info:eric/&rft_id=info:doi/

O'Riordan, M., & Passetti, F. (2006). Discrimination in autism within different sensory modalities. *Journal of Autism and Developmental Disorders, 36*(5), 665-675.

O'Roak, B. J., Vives, L., Girirajan, S., Karakoc, E., Krumm, N., Coe, B. P., . . . Smith, J. D. (2012). Sporadic autism exomes reveal a highly interconnected protein network of de novo mutations. *Nature, 485*(7397), 246-250.

Ochsner, K. N., & Gross, J. J. (2005). The cognitive control of emotion. *Trends in Cognitive Sciences, 9*(5), 242-249. doi:https://doi.org/10.1016/j.tics.2005.03.010

Odom, S. L., Collet-Klingenberg, L., Rogers, S. J., & Hatton, D. D. (2010). Evidence-based practices in interventions for children and youth with autism spectrum disorders. *Preventing School Failure: Alternative Education for Children and Youth, 54*(4), 275-282.

Odriozola, P., Uddin, L. Q., Lynch, C. J., Kochalka, J., Chen, T., & Menon, V. (2016). Insula response and connectivity during social and non-social attention in children with autism. *Social Cognitive and Affective Neuroscience, 11*(3), 433-444. doi:10.1093/scan/nsv126

Oram Cardy, J. E., Flagg, E. J., Roberts, W., & Roberts, T. P. L. (2005). Delayed mismatch field for speech and non-speech sounds in children with autism.

NeuroReport, *16*(5), 521-525. Retrieved from http://journals.lww.com/neuroreport/Fulltext/2005/04040/Delayed_mismatch_field_for_speech_and_non_speech.21.aspx

Oriel, K. N., George, C. L., Peckus, R., & Semon, A. (2011). The effects of aerobic exercise on academic engagement in young children with autism spectrum disorder. *Pediatric Physical Therapy*, *23*(2), 187-193.

Ornitz, E. M. (1970). Vestibular dysfunction in schizophrenia and childhood autism. *Comprehensive Psychiatry, 11*(2), 159-173. doi:https://doi.org/10.1016/0010-440X(70)90157-4

OT for Kids. *OT for Kids.* Retrieved from http://www.otforkids.co.uk/index.php

Ottenbacher, K. (1982). Sensory integration therapy: Affect or effect. *American Journal of Occupational Therapy*, *36*(9), 571-578.

Ozonoff, S. (1995). Executive functions in autism. In *Learning and cognition in autism* (pp. 199-219): Springer.

Ozonoff, S., & McEvoy, R. E. (1994). A longitudinal study of executive function and theory of mind development in autism. *Development and psychopathology*, *6*(3), 415-431.

Ozonoff, S., Young, G. S., Goldring, S., Greiss-Hess, L., Herrera, A. M., Steele, J., . . . Rogers, S. J. (2008). Gross Motor Development, Movement Abnormalities, and Early Identification of Autism. *Journal of Autism and Developmental Disorders*, *38*(4), 644-656. doi:10.1007/s10803-007-0430-0

Parham, L. D. (2002). Sensory integration and occupation. In *Sensory integration: Theory and practice* (2nd ed ed., pp. 413-434). Philadelphia: F. A. Davis Company.

Parham, L. D., Cohn, E. S., Spitzer, S., Koomar, J. A., Miller, L. J., Burke, J. P., . . . Summers, C. A. (2007). Fidelity in sensory integration intervention research. *AJOT:*

American Journal of Occupational Therapy, 61, 216+. Retrieved from http://go.galegroup.com.ezproxy.flinders.edu.au/ps/i.do?p=EAIM&sw=w&u=flinders&v=2.1&it=r&id=GALE%7CA208275791&asid=66bf3b93bf022fbe5ae812a8bbe4abfa

Parham, L. D., Roley, S. S., May-Benson, T. A., Koomar, J., Brett-Green, B., Burke, J. P., . . . Schaaf, R. C. (2011). Development of a fidelity measure for research on the effectiveness of the Ayres Sensory Integration® intervention. *American Journal of Occupational Therapy, 65*(2), 133-142.

Parker, R. I., & Brossart, D. F. (2003). Evaluating single-case research data: A comparison of seven statistical methods. *Behavior Therapy, 34*(2), 189-211.

Parker, R. I., & Vannest, K. (2009). An improved effect size for single-case research: Nonoverlap of all pairs. *Behavior Therapy, 40*(4), 357-367.

Parker, R. I., Vannest, K. J., & Brown, L. (2009). The improvement rate difference for single-case research. *Exceptional Children, 75*(2), 135-150.

Parker, R. I., Vannest, K. J., & Davis, J. L. (2011). Effect size in single-case research: A review of nine nonoverlap techniques. *Behavior Modification, 35*(4), 303-322.

Pellicano, E. (2007). Links between theory of mind and executive function in young children with autism: clues to developmental primacy. *Developmental psychology, 43*(4), 974.

Pellicano, E., & Burr, D. (2012). When the world becomes 'too real': a Bayesian explanation of autistic perception. *Trends in Cognitive Sciences, 16*(10), 504-510.

Perreault, A., Habak, C., Lepore, F., Mottron, L., & Bertone, A. (2015). Behavioral evidence for a functional link between low- and mid-level visual perception in the autism spectrum. *Neuropsychologia, 77*, 380-386. doi:http://dx.doi.org/10.1016/j.neuropsychologia.2015.09.022

Pfeiffer, B. A., Koenig, K., Kinnealey, M., Sheppard, M., & Henderson, L. (2011). *Effectiveness of sensory integration interventions in children with autism spectrum disorders: A pilot study* (Vol. 65).

Phillips, M. L., Ladouceur, C. D., & Drevets, W. C. (2008). A neural model of voluntary and automatic emotion regulation: implications for understanding the pathophysiology and neurodevelopment of bipolar disorder. In: Nature Publishing Group.

Piaget, J. (1964). Part I: Cognitive development in children: Piaget development and learning. *Journal of research in science teaching, 2*(3), 176-186.

Piaget, J. (2013). *The mechanisms of perception*: Routledge.

Pierce, K. (2011). Early functional brain development in autism and the promise of sleep fMRI. *Brain research, 1380*, 162-174.

Piggot, J., Shirinyan, D., Shemmassian, S., Vazirian, S., & Alarcón, M. (2009). Neural systems approaches to the neurogenetics of autism spectrum disorders. *Neuroscience, 164*(1), 247-256. doi:http://dx.doi.org/10.1016/j.neuroscience.2009.05.054

Pisha, B., & Coyne, P. (2001). Smart from the start: The promise of universal design for learning. *Remedial and Special Education, 22*(4), 197. Retrieved from https://search.proquest.com/docview/236257933?accountid=10910

http://flinders-primo.hosted.exlibrisgroup.com/openurl/61FUL/FUL_SERVICES_PAGE??url_ver=Z39.88-2004&rft_val_fmt=info:ofi/fmt:kev:mtx:journal&genre=article&sid=ProQ:ProQ%3Apsychology&atitle=Smart+from+the+start%3A+The+promise+of+universal+design+for+learning%3A+RASE+RASE+TL+%26+LD&title=Remedial+and+Special+Educa

tion&issn=07419325&date=2001-07-01&volume=22&issue=4&spage=197&au=Pisha%2C+Bart%3BCoyne%2C+Peggy&isbn=&jtitle=Remedial+and+Special+Education&btitle=&rft_id=info:eric/&rft_id=info:doi/

Plaisted, K., Saksida, L., Alcántara, J., & Weisblatt, E. (2003). Towards an understanding of the mechanisms of weak central coherence effects: Experiments in visual configural learning and auditory perception. *Philosophical Transactions of the Royal Society B: Biological Sciences, 358*(1430), 375-386.

Powell, M. (2013). Implementing the Alert Program for self-regulation through the response to intervention model with selected at-risk children: collaborating with elementary education teachers to identify effective strategies for improving student's readiness to learn.

Premack, D., & Woodruff, G. (1978). Does the chimpanzee have a theory of mind? *Behavioral and brain sciences, 1*(4), 515-526.

Prior, M., & Hoffmann, W. (1990). Brief report: Neuropsychological testing of autistic children through an exploration with frontal lobe tests. *Journal of Autism and Developmental Disorders, 20*(4), 581-590. doi:10.1007/bf02216063

Purdue University. (2013). APA formatting and style guide. Retrieved from https://owl.english.purdue.edu

Ragonese, J. A. (2008). Understanding sensory integration dysfunction: A case study. *3297564*.

Raiten, D. J., & Massaro, T. (1986). Perspectives on the nutritional ecology of autistic children. *Journal of Autism and Developmental Disorders, 16*(2), 133-143.

Randall, M., Sciberras, E., Brignell, A., Ihsen, E., Efron, D., Dissanayake, C., & Williams, K. (2016). Autism spectrum disorder: Presentation and prevalence in a nationally representative Australian sample. *Australian & New Zealand Journal of Psychiatry, 50*(3), 243-253.

Ray, T. C., King, L. J., & Grandin, T. (1988). The effectiveness of self-initiated vestibular stimulation in producing speech sounds in an autistic child. *OTJR, 8*(3), 186.

Reese, E. P., Howard, J., & Reese, T. W. (1978). *Human operant behavior: Analysis and application*: William C Brown Pub.

Reichle, J. (1990). National working conference on positive approaches to the management of excess behavior: Final report and recommendations. *Minneapolis, MN: Institute on Community Integration, University of Minnesota*.

Reichow, B., Barton, E. E., Sewell, J. N., Good, L., & Wolery, M. (2009). Effects of weighted vests on the engagement of children with developmental delays and autism. *Focus on Autism and Other Developmental Disabilities*.

Reilly, C., Nelson, D. L., & Bundy, A. C. (1983). Sensorimotor versus fine motor activities in eliciting vocalizations in autistic children. *OTJR: Occupation, Participation and Health, 3*(4), 199-212.

Reynolds, S., Bendixen, R. M., Lawrence, T., & Lane, S. J. (2011). A pilot study examining activity participation, sensory responsiveness, and competence in children with high functioning autism spectrum disorder. *Journal of Autism and Developmental Disorders, 41*(11), 1496-1506.

Reynolds, S., Lane, S. J., & Thacker, L. (2012). Sensory processing, physiological stress, and sleep behaviors in children with and without autism spectrum disorders. *OTJR: Occupation, Participation and Health, 32*(1), 246-257.

Richards, S. B., Taylor, R., & Ramasamy, R. (2013a). Issues in single subject research. In *Single Subject Research: Applications in Educational and Clinical Settings* (2nd ed., pp. 91-112). Belmont, CA: Cengage.

Richards, S. B., Taylor, R., & Ramasamy, R. (2013b). Overview of multiple baseline designs. In *Single subject research: Applications in educational and clinical settings* (2 ed., pp. 206-233). Belmonte: Cengage Learning.

Richey, J. A., Damiano, C. R., Sabatino, A., Rittenberg, A., Petty, C., Bizzell, J., . . . Smoski, M. (2015). Neural mechanisms of emotion regulation in autism spectrum disorder. *Journal of Autism and Developmental Disorders, 45*(11), 3409-3423.

Rinehart, N. J., Bradshaw, J. L., Moss, S. A., Brereton, A. V., & Tonge, B. J. (2001). A deficit in shifting attention present in high-functioning autism but not Asperger's disorder. *Autism, 5*(1), 67-80.

Rizzolatti, G., Fadiga, L., Gallese, V., & Fogassi, L. (1996). Premotor cortex and the recognition of motor actions. *Cognitive Brain Research, 3*(2), 131-141.

Roberts, M. E., Clarkson, J. J., Cummings, E. L. T., & Ragsdale, C. M. (2017). Facilitating emotional regulation: The interactive effect of resource availability and reward processing. *Journal of Experimental Social Psychology, 69*, 65-70. doi:https://doi.org/10.1016/j.jesp.2016.09.002

Robertson, K., Chamberlain, B., & Kasari, C. (2003). General education teachers' relationships with included students with autism. *Journal of Autism and Developmental Disorders, 33*(2), 123-130.

Robinson, D. (2017). Effective inclusive teacher education for special educational needs and disabilities: Some more thoughts on the way forward. *Teaching and Teacher Education, 61*, 164-178. doi:https://doi.org/10.1016/j.tate.2016.09.007

Rogers, S. J., & Ozonoff, S. (2005). Annotation: What do we know about sensory dysfunction in autism? A critical review of the empirical evidence. *Journal of Child Psychology and Psychiatry, 46*(12), 1255-1268.

Rubenstein, J., & Merzenich, M. M. (2003). Model of autism: increased ratio of excitation/inhibition in key neural systems. *Genes, Brain and Behavior, 2*(5), 255-267.

Ruddock, P. (2005). Disability standards for education 2005. In: Retrieved.

Rudie, J. D., Shehzad, Z., Hernandez, L. M., Colich, N. L., Bookheimer, S. Y., Iacoboni, M., & Dapretto, M. (2012). Reduced Functional Integration and Segregation of Distributed Neural Systems Underlying Social and Emotional Information Processing in Autism Spectrum Disorders. *Cerebral Cortex, 22*(5), 1025-1037. doi:10.1093/cercor/bhr171

Ruff, C. C., & Fehr, E. (2014). The neurobiology of rewards and values in social decision making. *Nature Reviews Neuroscience, 15*(8), 549-562.

Russell, J. E. (1997). *Autism as an executive disorder*: Oxford University Press.

Russo, N., Foxe, J. J., Brandwein, A. B., Altschuler, T., Gomes, H., & Molholm, S. (2010). Multisensory processing in children with autism: high‐density electrical mapping of auditory–somatosensory integration. *Autism Research, 3*(5), 253-267.

Samson, A. C., Hardan, A. Y., Lee, I. A., Phillips, J. M., & Gross, J. J. (2015). Maladaptive behavior in autism spectrum disorder: the role of emotion experience and emotion regulation. *Journal of Autism and Developmental Disorders, 45*(11), 3424-3432.

Samson, A. C., Hardan, A. Y., Podell, R. W., Phillips, J. M., & Gross, J. J. (2015). Emotion regulation in children and adolescents with autism spectrum disorder. *Autism Research, 8*(1), 9-18.

Samson, A. C., Phillips, J. M., Parker, K. J., Shah, S., Gross, J. J., & Hardan, A. Y. (2014). Emotion dysregulation and the core features of autism spectrum disorder. *Journal of Autism and Developmental Disorders, 44*(7), 1766-1772.

Samson, A. C., Wells, W. M., Phillips, J. M., Hardan, A. Y., & Gross, J. J. (2015). Emotion regulation in autism spectrum disorder: evidence from parent interviews and children's daily diaries. *Journal of Child Psychology and Psychiatry, 56*(8), 903-913.

Sanz-Cervera, P., Pastor-Cerezuela, G., Fernández-Andrés, M.-I., & Tárraga-Mínguez, R. (2015). Sensory processing in children with Autism Spectrum Disorder: Relationship with non-verbal IQ, autism severity and Attention Deficit/Hyperactivity Disorder symptomatology. *Research in Developmental Disabilities, 45–46*, 188-201. doi:http://dx.doi.org/10.1016/j.ridd.2015.07.031

Sayers, B. R. (2008). Collaboration in School Settings: A Critical Appraisal of the Topic. *Journal of Occupational Therapy, Schools, & Early Intervention, 1*(2), 170-179. doi:10.1080/19411240802384318

Schaaf, R. C., Benevides, T., Mailloux, Z., Faller, P., Hunt, J., van Hooydonk, E., . . . Kelly, D. (2014). An Intervention for Sensory Difficulties in Children with Autism: A Randomized Trial. *Journal of Autism and Developmental Disorders, 44*(7), 1493-1506. doi:10.1007/s10803-013-1983-8

Schaaf, R. C., Dumont, R. L., Arbesman, M., & May-Benson, T. A. (2018). Efficacy of occupational therapy using Ayres Sensory Integration®: A systematic review. *American Journal of Occupational Therapy, 72*(1), 7201190010p7201190011-7201190010p7201190010.

Schaaf, R. C., & Nightlinger, K. M. (2007). Occupational therapy using a sensory integrative approach: A case study of effectiveness. *American Journal of Occupational Therapy, 61*(2), 239-246.

Scheeren, A. M., Banerjee, R., Koot, H. M., & Begeer, S. (2016). Self-Presentation and the Role of Perspective Taking and Social Motivation in Autism Spectrum Disorder. *Journal of Autism and Developmental Disorders, 46*(2), 649-657.

Schmitt, L., Heiss, C. J., & Campbell, E. E. (2008). A comparison of nutrient intake and eating behaviors of boys with and without autism. *Topics in Clinical Nutrition, 23*(1), 23-31.

Schoen, S. A., Lane, S. J., Mailloux, Z., May‐Benson, T., Parham, L. D., Smith Roley, S., & Schaaf, R. C. (2019). A systematic review of ayres sensory integration intervention for children with autism. *Autism Research, 12*(1), 6-19. doi:10.1002/aur.2046

Schopler, E., Brehm, S. S., Kinsbourne, M., & Reichler, R. J. (1971). Effect of treatment structure on development in autistic children. *Archives of General Psychiatry, 24*(5), 415-421.

Schreck, K. A., Williams, K., & Smith, A. F. (2004). A comparison of eating behaviors between children with and without autism. *Journal of Autism and Developmental Disorders, 34*(4), 433-438.

Schroeder, J. H., Desrocher, M., Bebko, J. M., & Cappadocia, M. C. (2010). The neurobiology of autism: Theoretical applications. *Research in Autism Spectrum Disorders, 4*(4), 555-564.

Scott, J., Clark, C., & Brady, M. (2000a). A brief history of autism. In *Students with Autism: Characteristics' and institutional programming* (pp. 41-68). California, USA: Singular Publishing Group.

Scott, J., Clark, C., & Brady, M. (2000b). Parents and Families. In *Students with Autism: Characteristics and Instructional Programming* (pp. 329-379). California, USA: Singular Publishing Group.

Seery, A. M., Vogel-Farley, V., Tager-Flusberg, H., & Nelson, C. A. (2013). Atypical lateralization of ERP response to native and non-native speech in infants at risk for autism spectrum disorder. *Developmental cognitive neuroscience, 5*, 10-24. doi:https://doi.org/10.1016/j.dcn.2012.11.007

Shadish, W. R. (2014). Analysis and meta-analysis of single-case designs: An introduction. *Journal of School Psychology, 52*(2), 109-122.

Shadish, W. R., & Sullivan, K. J. (2011). Characteristics of single-case designs used to assess intervention effects in 2008. *Behavior Research Methods, 43*(4), 971-980.

Sharp, W. G., Berry, R. C., McCracken, C., Nuhu, N. N., Marvel, E., Saulnier, C. A., . . . Jaquess, D. L. (2013). Feeding Problems and Nutrient Intake in Children with Autism Spectrum Disorders: A Meta-analysis and Comprehensive Review of the Literature (journal article) (Publication no. 10.1007/s10803-013-1771-5). (1573-3432). http://dx.doi.org/10.1007/s10803-013-1771-5

Shoener, R. F., Kinnealey, M., & Koenig, K. P. (2008). You can know me now if you listen: Sensory, motor, and communication issues in a nonverbal person with autism. *American Journal of Occupational Therapy, 62*(5), 547-553.

Smith, K., & Matson, J. (2010). Behavior problems: Differences among intellectually disabled adults with co-morbid autism spectrum disorders and epilepsy. *Research in Developmental Disabilities, 31*(5), 1062-1069. doi:https://doi.org/10.1016/j.ridd.2010.04.003

Smith, M., Rogers, S., & Dawson, G. (2008). The Early Start Denver Model: a comprehensive early intervention approach for toddlers with autism. *Preschool Education Programs for Children With Autism. 3rd ed. Austin, TX: Pro-Ed Corporation, Inc*, 65-101.

Smith Roley, S., Mailloux, Z., Miller-Kuhaneck, H., & Glennon, T. (2007). Understanding Ayres' Sensory Integration.

Smith, S. A., Press, B., Koenig, K. P., & Kinnealey, M. (2005). Effects of sensory integration intervention on self-stimulating and self-injurious behaviors. *AJOT: American Journal of Occupational Therapy, 59*, 418+. Retrieved from http://go.galegroup.com.ezproxy.flinders.edu.au/ps/i.do?p=EAIM&sw=w&u=flinders&v=2.1&it=r&id=GALE%7CA208275690&asid=9c51bee2d62ce5bc55a63c1c2a7c17c4

Snijders, T. M., Milivojevic, B., & Kemner, C. (2013). Atypical excitation–inhibition balance in autism captured by the gamma response to contextual modulation. *NeuroImage: Clinical, 3*, 65-72.

Southgate, V., & Hamilton, A. F. d. C. (2008). Unbroken mirrors: Challenging a theory of autism. *Trends in Cognitive Sciences, 12*(6), 225-229.

Spencer, M. D., Moorhead, T. W. J., Lymer, G. K. S., Job, D. E., Muir, W. J., Hoare, P., . . . Johnstone, E. C. (2006). Structural correlates of intellectual impairment and autistic features in adolescents. *NeuroImage, 33*(4), 1136-1144. doi:https://doi.org/10.1016/j.neuroimage.2006.08.011

Srivastava, A. K., & Schwartz, C. E. (2014). Intellectual disability and autism spectrum disorders: Causal genes and molecular mechanisms. *Neuroscience & Biobehavioral Reviews, 46*, 161-174. doi:https://doi.org/10.1016/j.neubiorev.2014.02.015

Stevenson, R. A., Segers, M., Ferber, S., Barense, M. D., & Wallace, M. T. (2015). The impact of multisensory integration deficits on speech perception in children with autism spectrum disorders. *Multisensory and sensorimotor interactions in speech perception*, 249.

Stigler, K. A., McDonald, B. C., Anand, A., Saykin, A. J., & McDougle, C. J. (2011). Structural and functional magnetic resonance imaging of autism spectrum disorders. *Brain research, 1380*, 146-161.

Strang, J. F., Kenworthy, L., Daniolos, P., Case, L., Wills, M. C., Martin, A., & Wallace, G. L. (2012). Depression and anxiety symptoms in children and adolescents with autism spectrum disorders without intellectual disability. *Research in Autism Spectrum Disorders*, *6*(1), 406-412. doi:https://doi.org/10.1016/j.rasd.2011.06.015

Swain, D., Scarpa, A., White, S., & Laugeson, E. (2015). Emotion Dysregulation and Anxiety in Adults with ASD: Does Social Motivation Play a Role? *Journal of Autism and Developmental Disorders*, *45*(12), 3971-3977.

Swettenham, J., Baron-Cohen, S., Charman, T., Cox, A., Baird, G., Drew, A., . . . Wheelwright, S. (1998). The frequency and distribution of spontaneous attention shifts between social and nonsocial stimuli in autistic, typically developing, and nonautistic developmentally delayed infants. *Journal of Child Psychology and Psychiatry*, *39*(05), 747-753.

Tallantyre, E., & Robertson, N. P. (2013). Autism and intellectual disability. *Journal of Neurology*, *260*(3), 936-939. doi:10.1007/s00415-013-6861-y

Tárrega, S., Fagundo, A. B., Jiménez-Murcia, S., Granero, R., Giner-Bartolomé, C., Forcano, L., . . . Magnenat-Thalmann, N. (2014). Explicit and implicit emotional expression in bulimia nervosa in the acute state and after recovery. *PLoS ONE*, *9*(7), e101639.

Tawney, J. W., & Gast, D. L. (1985). *Single subject research in special education*: Merrill.

Tomchek, S. D., & Dunn, W. (2007). Sensory processing in children with and without autism: a comparative study using the short sensory profile. *American Journal of Occupational Therapy, 61*(2), 190-200.

Tucker, V., & Schwartz, I. (2013). Parents' perspectives of collaboration with school professionals: Barriers and facilitators to successful partnerships in planning for students with ASD. *School Mental Health, 5*(1), 3-14.

Uchida, M., Biederman, J., Gabrieli, J. D., Micco, J., de Los Angeles, C., Brown, A., . . . Whitfield-Gabrieli, S. (2015). Emotion regulation ability varies in relation to intrinsic functional brain architecture. *Social Cognitive and Affective Neuroscience*, nsv059.

UNESCO. (1994). *The Salamanca Statement and Framework for Action*. Retrieved from Salamanca, Spain:

Van Praag, H., Kempermann, G., & Gage, F. H. (2000). Neural consequences of environmental enrichment. *Nature reviews. Neuroscience, 1*(3), 191.

Vandenbroucke, M. W. S., H S; van Engelend, H; Lamme, V A; Kemner, C. (2008). A neural substrate for atypical low-level visual processing in autism spectrum disorder. *Brain, 131*, 1013-1024.

Vannest, K., & Ninci, J. (2015). Evaluating Intervention Effects in Single-Case Research Designs. *Journal of Counseling & Development, 93*(4), 403-411.

Vannest, K., Parker, R., & Gonen, O. (2011). Single Case Research: web based calculators for SCR analysis. *College Station, TX: Texas A&M University.* Retrieved from http://www.singlecaseresearch.org/calculators/ird

Vargas, D. L., Nascimbene, C., Krishnan, C., Zimmerman, A. W., & Pardo, C. A. (2005). Neuroglial activation and neuroinflammation in the brain of patients with autism. *Annals of neurology, 57*(1), 67-81.

Vargas, S., & Camilli, G. (1999). A meta-analysis of research on sensory integration treatment. *American Journal of Occupational Therapy, 53*(2), 189-198.

Vaughn, S., & Bos, C. (2009). Approaches to learning and teaching. In *Strategies for teaching students with learning and behavior problems* (7th ed ed.). Boston: Pearson/Allyn and Bacon.

Verma, J. (2015). Analysis of variance and Repeated Measures design. In *Repeated Measures Design for Empirical Researchers* (pp. 153-189). New Jersey, USA: Hoboken, New Jersey : John Wiley & Sons, Incorporated.

Villeneuve, M. A., & Shulha, L. M. (2012). Learning together for effective collaboration in school-based occupational therapy practice. *Canadian Journal of Occupational Therapy, 79*(5), 293-302.

Visser, E. M., Berger, H. J. C., Prins, J. B., Van Schrojenstein Lantman-De Valk, H. M. J., & Teunisse, J. P. (2014). Shifting impairment and aggression in intellectual disability and Autism Spectrum Disorder. *Research in Developmental Disabilities, 35*(9), 2137-2147. doi:https://doi.org/10.1016/j.ridd.2014.04.021

Vivanti, G., Barbaro, J., Hudry, K., Dissanayake, C., & Prior, M. (2013). Intellectual Development in Autism Spectrum Disorders: New Insights from Longitudinal Studies. *Frontiers in Human Neuroscience, 7*, 354. doi:10.3389/fnhum.2013.00354

Vlamings, P. H. J. M., Jonkman, L. M., van Daalen, E., van der Gaag, R. J., & Kemner, C. (2010). Basic abnormalities in visual processing affect face processing at an early age in autism spectrum disorder. *Biological Psychiatry, 68*(12), 1107-1113.

Vygotsky, L. S. (1980). *Mind in society: The development of higher psychological processes*: Harvard university press.

Wallace, G. L., Dankner, N., Kenworthy, L., Giedd, J. N., & Martin, A. (2010). Age-related temporal and parietal cortical thinning in autism spectrum disorders. *Brain, 133*(12), 3745-3754. doi:10.1093/brain/awq279

Wang, Y., & Hamilton, A. F. d. C. (2012). Social top-down response modulation (STORM): a model of the control of mimicry in social interaction.

Wass, S. (2011). Distortions and disconnections: disrupted brain connectivity in autism. *Brain and cognition*, *75*(1), 18-28.

Watling, R. L., & Dietz, J. (2007). Immediate effect of Ayres's sensory integration–based occupational therapy intervention on children with autism spectrum disorders. *American Journal of Occupational Therapy, 61*(5), 574-583.

Wells, A. M., Chasnoff, I. J., Schmidt, C. A., Telford, E., & Schwartz, L. D. (2012). Neurocognitive habilitation therapy for children with fetal alcohol spectrum disorders: an adaptation of the Alert Program®. *American Journal of Occupational Therapy, 66*(1), 24-34.

Westwood, P. (2004). Perspectives on Learning. In *Learning and Learning Difficulties: A Handbook for Teachers* (pp. 1-16). Camberwell, Vic: ACER Press.

White, S. W., Mazefsky, C. A., Dichter, G. S., Chiu, P. H., Richey, J. A., & Ollendick, T. H. (2014). Social-cognitive, physiological, and neural mechanisms underlying emotion regulation impairments: Understanding anxiety in autism spectrum disorder. *International Journal of Developmental Neuroscience, 39*, 22-36.

White, S. W., Oswald, D., Ollendick, T., & Scahill, L. (2009). Anxiety in children and adolescents with autism spectrum disorders. *Clinical Psychology Review, 29*(3), 216-229.

Whitehouse, A. J., & Bishop, D. V. (2008). Do children with autism 'switch off' to speech sounds? An investigation using event-related potentials. *Developmental Science, 11*(4), 516-524.

Whiteley, P., Rodgers, J., & Shattock, P. (2000). Feeding patterns in autism. *Autism, 4*(2), 207-211.

Wiens, S. (2005). Interoception in emotional experience. *Current opinion in neurology, 18*(4), 442-447.

Wiggins, J. L., Kurapati, N., Carrasco, M., & Maslowsky, J. (2010). Neural circuitry of emotional face processing in autism spectrum disorders. *Journal of psychiatry & neuroscience: JPN, 35*(2), 105.

Wigham, S., Rodgers, J., South, M., McConachie, H., & Freeston, M. (2015). The Interplay Between Sensory Processing Abnormalities, Intolerance of Uncertainty, Anxiety and Restricted and Repetitive Behaviours in Autism Spectrum Disorder. *Journal of Autism and Developmental Disorders, 45*(4), 943-952. doi:10.1007/s10803-014-2248-x

Wilbarger, J., & Wilbarger, P. (2002). Alternative and complementary programs for intervention. In A. C. Bundy, S. J. Lane, & E. A. Murray (Eds.), *Sensory integration: Theory and practice* (2nd ed. ed., pp. 335-341). Philadelpjia: F. A. Davis and Company.

Williams, & Shellenberger, S. (2002). "How Does Your Engine Run?": The Alert program for self regulation. In A. C. Bundy, S. J. Lane, & E. A. Murray (Eds.), *Sensory Integration: Theory and Oractice* (2nd ed ed., pp. 342-345). Philadelphia: F. A. Davis and Company.

Williams, D. L., Goldstein, G., & Minshew, N. J. (2005). Impaired memory for faces and social scenes in autism: clinical implications of memory dysfunction. *Archives of Clinical Neuropsychology, 20*(1), 1-15. doi:10.1016/j.acn.2002.08.001

Williams, K. E., Gibbons, B. G., & Schreck, K. A. (2005). Comparing selective eaters with and without developmental disabilities. *Journal of Developmental and Physical Disabilities, 17*(3), 299-309.

Williams, P. G., Dalrymple, N., & Neal, J. (2000). Eating habits of children with autism. *Pediatric nursing, 26*(3), 259.

Williams White, S., Keonig, K., & Scahill, L. (2007). Social Skills Development in Children with Autism Spectrum Disorders: A Review of the Intervention Research. *Journal of Autism and Developmental Disorders, 37*(10), 1858-1868. doi:10.1007/s10803-006-0320-x

Wong, C., Odom, S. L., Hume, K. A., Cox, A. W., Fettig, A., Kucharczyk, S., . . . Schultz, T. R. (2015). Evidence-based practices for children, youth, and young adults with autism spectrum disorder: A comprehensive review. *Journal of Autism and Developmental Disorders, 45*(7), 1951-1966.

Zissermann, L. (1992). The effects of deep pressure on self-stimulating behaviors in a child with autism and other disabilities. *American Journal of Occupational Therapy, 46*(6), 547-551.

Zobel-Lachiusa, J., Andrianopoulos, M. V., Mailloux, Z., & Cermak, S. A. (2015). Sensory differences and mealtime behavior in children with autism. *American Journal of Occupational Therapy, 69*(5), 6905185050p6905185051-6905185050p6905185058.

Zoghbi, H. Y., & Bear, M. F. (2012). Synaptic dysfunction in neurodevelopmental disorders associated with autism and intellectual disabilities. *Cold Spring Harbor perspectives in biology, 4*(3), a009886.

Appendix A.

Direct Observation Record Form

Student Observation Record- Name: ___________________________

Social Behaviour- initiation of interaction with adult or peer (Frequency)

	Tally of social interactions Yard play-30 minutes (ten-minutes per student)
Day1	
Day 2	
Day 3	

Engagement with task- partial interval recording of focus on table task

	1 min		2 min		3 min		4 min		5 min		6 min		7 min		8 min		9 min		10 min	
Day 1																				
Day 2																				
Day 3																				

Emotional behaviour- Frequency (F), duration (D) (measured from the time started to time finished)

Day 1

F														
D														

Day 2

F														
D														

Day 3

F														
D														

Appendix B.

Social Validation Questionnaire

Validator - ____________________________________

You will view 4 pre- and post-intervention video tapes of a student during yard play. Complete a questionnaire for videos labeled **T** and another for videos labeled **R**. You are requested to view each tape one at a time and then complete the questionnaire. For question 1, you are required to indicate the frequency of initiation of social interaction by putting a tick every time you view specific behaviours like looking at another person, approaching or touching another person, verbalizing or vocalizing at another person. Then in Q2, rate the nature of initiation of social interaction you consider most appropriate for the student by putting a tick in the appropriate box on the given scale.

1. Number of times you saw the student: looking at another person, approaching or touching another person, verbalizing or vocalizing at another person (using either sounds or words)

Clip T	
Clip R	

2. What is the observed nature of initiation of social interaction by the student?

Student	**No initiation**	**Rare initiations**	**Occasional initiations**	**Some initiation**	**Frequent initiation**
Clip T					
Clip R					

3. How did the student appear during the social interaction? eg. Calm, happy

Clip T

____

____

Clip R

____

____

Figure B. *Social validation questionnaire for student initiated social interactions (side 1)*

Validator - ______________________________

You will view 4 video tapes of the same students, pre and post-intervention, engaged in a routine tabletop task. You are requested to view each student one at a time and indicate your perception of the student's focus on task. First, put a tick every time you view the student exhibit behaviours that indicate their engagement with task, e.g. looking/ touching/interacting with study material and/or interacting with instructor, for Q4. Then indicate it on the given scale for Q5 by putting a tick in the appropriate box.

4. Number of times you saw the student: looking/ touching/interacting with study material, interacting with instructor.

Clip T										
Clip R										

5. What is the observed nature of focus on task by the student?

Student	**No focus**	**Rare focus**	**Occasional focus**	**Some focus**	**Prolonged focus**
Clip T					
Clip R					

4. How did the student appear while working at the tabletop task? Eg. Engaged, satisfied/ attentive, distracted, anything else

Clip T

____

____

Clip R

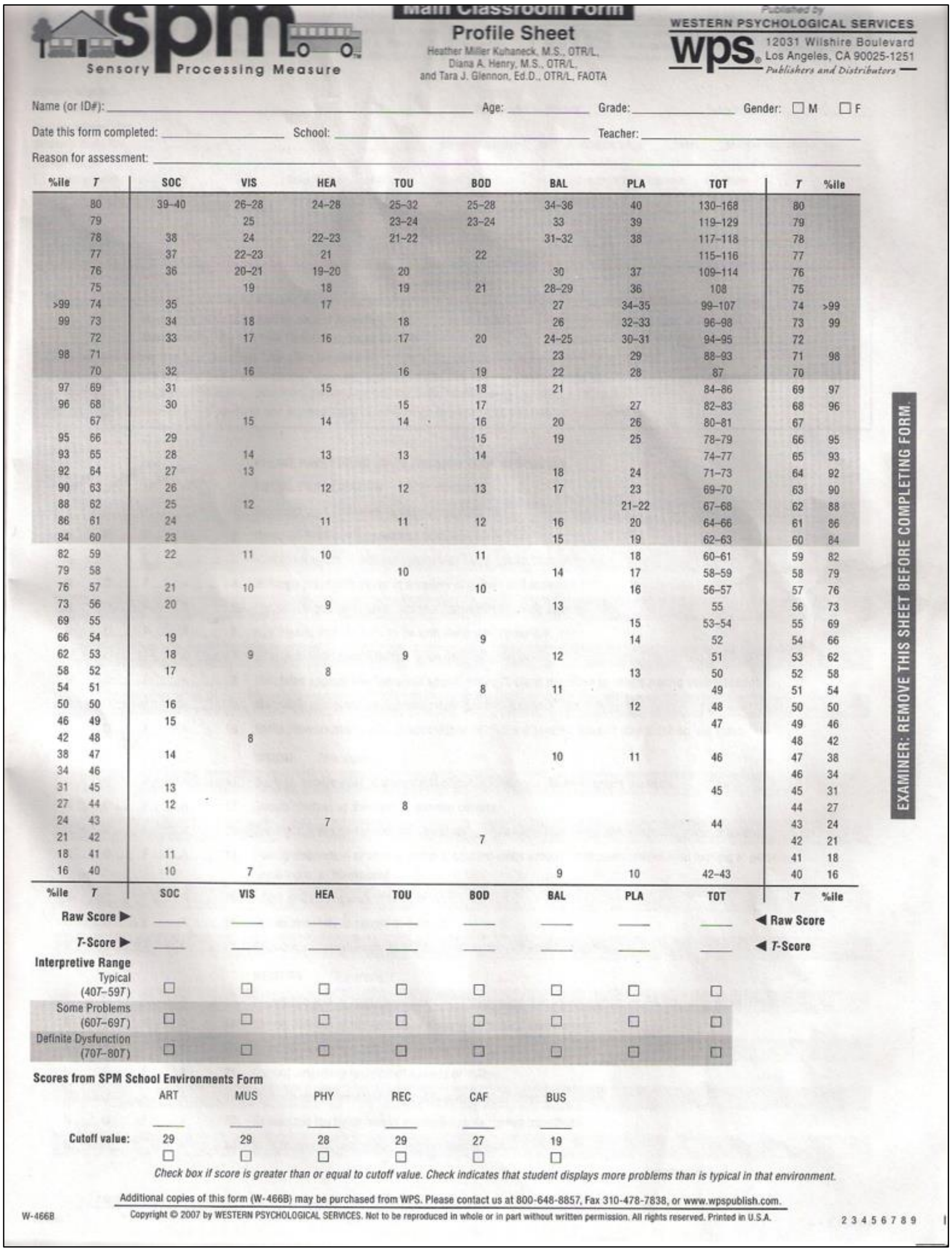
____

____

Figure B. *Social validation questionnaire for student initiated social interactions (side 2)*

Appendix C.

Sensory Processing Measure Form



spm Sensory Processing Measure

Main Classroom Form

Profile Sheet

Heather Miller Kuhaneck, M.S., OTR/L, Diana A. Henry, M.S., OTR/L, and Tara J. Glennon, Ed.D., OTR/L, FAOTA

Published by WESTERN PSYCHOLOGICAL SERVICES

wps. 12031 Wilshire Boulevard Los Angeles, CA 90025-1251 Publishers and Distributors

Name (or ID#): ______ Age: ______ Grade: ______ Gender: ☐ M ☐ F

Date this form completed: ______ School: ______ Teacher: ______

Reason for assessment: ______

%ile	T	SOC	VIS	HEA	TOU	BOD	BAL	PLA	TOT	T	%ile
	80	39–40	26–28	24–28	25–32	25–28	34–36	40	130–168	80	
	79		25		23–24	23–24	33	39	119–129	79	
	78	38	24	22–23	21–22		31–32	38	117–118	78	
	77	37	22–23	21		22			115–116	77	
	76	36	20–21	19–20	20		30	37	109–114	76	
	75		19	18	19	21	28–29	36	108	75	
>99	74	35		17			27	34–35	99–107	74	>99
99	73	34	18		18		26	32–33	96–98	73	99
	72	33	17	16	17	20	24–25	30–31	94–95	72	
98	71						23	29	88–93	71	98
	70	32	16		16	19	22	28	87	70	
97	69	31		15		18	21		84–86	69	97
96	68	30			15	17		27	82–83	68	96
	67		15	14	14	16	20	26	80–81	67	
95	66	29				15	19	25	78–79	66	95
93	65	28	14	13	13	14			74–77	65	93
92	64	27	13				18	24	71–73	64	92
90	63	26		12	12	13	17	23	69–70	63	90
88	62	25	12					21–22	67–68	62	88
86	61	24		11	11	12	16	20	64–66	61	86
84	60	23					15	19	62–63	60	84
82	59	22	11	10		11		18	60–61	59	82
79	58				10		14	17	58–59	58	79
76	57	21	10			10		16	56–57	57	76
73	56	20		9			13		55	56	73
69	55							15	53–54	55	69
66	54	19				9		14	52	54	66
62	53	18	9		9		12		51	53	62
58	52	17		8				13	50	52	58
54	51					8	11		49	51	54
50	50	16						12	48	50	50
46	49	15							47	49	46
42	48		8							48	42
38	47	14					10	11	46	47	38
34	46									46	34
31	45	13							45	45	31
27	44	12			8					44	27
24	43			7					44	43	24
21	42					7				42	21
18	41	11								41	18
16	40	10	7				9	10	42–43	40	16
%ile	T	SOC	VIS	HEA	TOU	BOD	BAL	PLA	TOT	T	%ile

	SOC	VIS	HEA	TOU	BOD	BAL	PLA	TOT	
Raw Score ▶	___	___	___	___	___	___	___	___	◀ Raw Score
T-Score ▶	___	___	___	___	___	___	___	___	◀ *T*-Score
Interpretive Range									
Typical (40*T*–59*T*)	☐	☐	☐	☐	☐	☐	☐	☐	
Some Problems (60*T*–69*T*)	☐	☐	☐	☐	☐	☐	☐	☐	
Definite Dysfunction (70*T*–80*T*)	☐	☐	☐	☐	☐	☐	☐	☐	

Scores from SPM School Environments Form

	ART	MUS	PHY	REC	CAF	BUS
	___	___	___	___	___	___
Cutoff value:	29	29	28	29	27	19
	☐	☐	☐	☐	☐	☐

Check box if score is greater than or equal to cutoff value. Check indicates that student displays more problems than is typical in that environment.

EXAMINER: REMOVE THIS SHEET BEFORE COMPLETING FORM.

Additional copies of this form (W-466B) may be purchased from WPS. Please contact us at 800-648-8857, Fax 310-478-7838, or www.wpspublish.com.

W-466B

2 3 4 5 6 7 8 9

Figure C. *Sensory Processing Measure, Main Classroom and School Environments Form that record: Balance and motion (BAL), body awareness (BOD), hearing (HEA), planning and ideas (PLA), social participation (SOC), touch (TOU), vision (VIS), and total sensory systems (TOT).*

Appendix D.

Fidelity Checklist (2014)

Table D. *SI INTERVENTION Fidelity checklist 2014. For the checklists for 2012 and 2013, see Appendix E.*

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Structural elements					
Therapist qualifications (training in sensory integration)					
Supervision by qualified therapist (min 1 hr/week by an expert of 5 yrs of providing OT to children based on SI principles)					
Components of pre-assessment					
a. Case history (admission reports, medical/prior school reports)					
b. Previous referrals					
c. Student observation (motor coordination, gross motor skills and praxis, self-organisation, sensory processing, postural ocular control, visual-perceptual and fine motor skills)					
Physical environment					
a. Adequate space for vigorous activity					
b. Flexible arrangement for equipment					
c. Hooks for suspended equipment					
d. Use of rotational devices attached to ceiling support					
e. Quiet space (tent, adjacent room)					
f. Bungee cords for suspended equipment					
g. Mats, cushions, pillows					
h. Equipment adjustable for child's size					
i. Monitoring of equipment for safe use					
j. Storage of unused equipment for safety					
k. Documentation for safe use of suspension equipment					
l. Variety of equipment available e.g. trampolines, therapy balls, thera-bands and ropes for pulling, swings, scooter board and ramp, weighted balls, bean bags, massagers, crash pillow, vibrating toys, tactile material, visual targets, climbing equipment, props for play					
Communication with parents					
a. Negotiated goal setting discussed with parent, teacher and therapist					
b. Family and/or teacher education					
Sensory integration Programme- Process elements					
a. Ensures physical safety					
b. Presents sensory opportunities					
c. Helps the child to attain and maintain					

optimal level of alertness					
d. Challenges postural, ocular, oral and/or bilateral motor control					
e. Challenges praxis and organisation of behaviour					
f. Collaborates in activity of choice					
g. Presents just-right challenge					
h. Activities are success-oriented					
i. Supports child's intrinsic motivation to play					
j. Establishes therapeutic alliance					

Adapted from (Parham et al., 2011)

Appendix E.

Fidelity Checklist (2012, 2013)

Table E. *SI INTERVENTION Fidelity Checklist (2012, 2013). For the checklist for 2014, see Appendix D.*

	2012	2013
Structural elements		
Therapist qualifications (training in sensory integration)		
Supervision by qualified therapist (min 1 hr/month by an expert of 5 yrs of providing OT to children based on SI principles)		
Components of pre-assessment		
d. Case history (admission reports, medical/prior school reports)		
e. Previous referrals		
f. Student observation (motor coordination, gross motor skills and praxis, self-organisation, sensory processing, postural ocular control, visual-perceptual and fine motor skills)		
Physical environment		
m. Adequate space for vigorous activity		
n. Flexible arrangement for equipment		
o. Hooks for suspended equipment		
p. Use of rotational devices attached to ceiling support		
q. Quiet space (tent, adjacent room)		
r. Bungee cords for suspended equipment		
s. Mats, cushions, pillows		
t. Equipment adjustable for child's size		
u. Monitoring of equipment for safe use		
v. Storage of unused equipment for safety		
w. Documentation for safe use of suspension equipment		
x. Variety of equipment available e.g. trampolines, therapy balls, thera-bands and ropes for pulling, swings, scooter board and ramp, weighted balls, bean bags, massagers, crash pillow, vibrating toys, tactile material, visual targets, climbing equipment, props for play		
Communication with parents		
c. Negotiated goal setting discussed with parent, teacher and therapist		
d. Family and/or teacher education		
Sensory integration Programme- Process elements		
k. Ensures physical safety		
l. Presents sensory opportunities		
m. Helps the child to attain and maintain		

	optimal level of alertness		
n.	Challenges postural, ocular, oral and/or bilateral motor control		
o.	Challenges praxis and organisation of behaviour		
p.	Collaborates in activity of choice		
q.	Presents just-right challenge		
r.	Activities are success-oriented		
s.	Supports child's intrinsic motivation to play		
t.	Establishes therapeutic alliance		

Adapted from *(Parham et al., 2011).*

Appendix F.

Letter of consent – Principal

Flinders UNIVERSITY

School of Education
GPO Box 2100
Adelaide SA 5001
Tel. 08 73228116
Swati.phatak@flinders.edu.au

CRICOS Provider No. 00114A

I

LETTER OF PERMISSION TO CONDUCT RESEARCH AT SCHOOL

I ………………………………………
being the Principal of the school where the research is proposed to be undertaken, hereby give permission to Mrs. Swati Phatak, to conduct data collection from the selected students for the research project on 'The Effects of a Sensory Integration Programme on behaviours of students with autism- task engagement, social interactions and emotional crises.'

1. I have read the information provided.
2. I agree to up to four, ten-minute video recording of each child participating in table task and during yard play, which will be used to verify data collected in the study. These recordings will remain completely confidential and parents will be asked to view these at the end of data collection for social validation of the study. Videos will be taken in the sight-view of staff at the school.
3. I am aware that I should retain a copy of the Information Sheet and Consent Form for future reference.
4. I understand that:
   - I will be asked to distribute Parents/Guardians Information Sheets and Parents/Guardians Consent Forms.
   - I will be required to assist in recruiting teachers to participate in the study.
   - While the information gained in this study will be published as explained, the school or the students participating in the study will not be identified, and individual information will remain confidential.
   - The researcher will have only minimal contact with participating students when assisting the class teacher to make observations for inter-rater reliability.
5. I have had the opportunity to discuss taking part in this research with colleagues, staff members and parents of participating students.

Participant's signature……………………………………….**Date**…………………….

I certify that I have explained the study to the volunteer and consider that she/he understands what is involved and freely consents to participation.

Researcher's name…Swati Phatak

Researcher's signature…………………………………….**Date**……………………..

NB: Two signed copies should be obtained. The copy retained by the researcher may then be used for authorisation of Items 8 and 9, as appropriate.

Appendix G.

Letter of consent – parent (social validation)

Flinders
UNIVERSITY

School of Education
GPO Box 2100
Adelaide SA 5001
Tel. 08 72298118

CRICOS Provider No. 00114A

LETTER OF CONSENT TO PARTICIPATE IN SOCIAL VALIDATION

I ....

consent to participate in the research project on 'The Effects of a Sensory Integration Programme on behaviours of students with autism- task engagement, social interactions and emotional crises.'

1. I have read the information provided.
2. Details of procedures and any risks have been explained to my satisfaction.
3. I agree to view the video recording of participating students at my school and completing a questionnaire after viewing with written permission from participants' parents.
4. I am aware that I should retain a copy of the Information Sheet and Consent Form for future reference.
5. I understand that:
   - I may not directly benefit from taking part in this research.
   - I am free to withdraw from the project at any time and am free to decline to answer particular questions.
   - While the information gained in this study will be published as explained, the students or school will not be identified, and individual information will remain confidential.
6. I have had the opportunity to discuss taking part in this research with colleagues, family member or friend.

Participant's signature...**Date**.......................

I certify that I have explained the study to the volunteer and consider that she/he understands what is involved and freely consents to participation.

Researcher's name... Swati Phatak

Researcher's signature..**Date**.........................

NB: Two signed copies should be obtained. The copy retained by the researcher may then be used for authorisation of Items 8 and 9, as appropriate.

Appendix H.

Letter of consent – parental consent

School of Education
GPO Box 2100
Adelaide SA 5001
Tel. 08 [illegible]
Swati.phatak@flinders.edu.au

CRICOS Provider No. 00114A

PARENTAL CONSENT FORM FOR CHILD PARTICIPATION IN RESEARCH
CONSENT FORM FOR PARTICIPATION IN RESEARCH
(By participation in the programme)

I ……………………………………………………………………………………………………
being over the age of 18 years hereby consent to my child ……………………………………
participating, as requested, in the Letter of Introduction for the research project on the Effects of a Sensory Integration Programme on behaviours of students with autism- task engagement, social interactions and emotional crises
I have read the information provided.

1. Details of procedures and any risks have been explained to my satisfaction.
2. I agree to video recording of my child's engagement at a table task and at yard play.
3. I am aware that I should retain a copy of the Information Sheet and Consent Form for future reference.
4. I understand that:
   - My child may not directly benefit from taking part in this research.
   - My child is free to withdraw from the project at any time and is free to decline to answer particular questions.
   - While the information gained in this study will be published as explained, my child will not be identified, and individual information will remain confidential.
   - Whether my child participates or not, or withdraws after participating, will have no effect on his/her progress in his/her course of schooling, or results gained.
   - My child may ask that the recording/observation be stopped at any time, and he/she may withdraw at any time from the session or the research without disadvantage.

6. I agree to the video tape being made available to the researcher and two other teaching staff for the purpose of social validation.
7. I agree to view the video clips of my child engaged in a table task and at yard play and complete a questionnaire about it, once it has been explained to me by the research student.
8. I have had the opportunity to discuss taking part in this research with a family member or friend.

Participant's signature……………………………………**Date**……………………

I certify that I have explained the study to the volunteer and consider that she/he understands what is involved and freely consents to participation.

Researcher's name…Swati Phatak
Researcher's signature……………………………………**Date**……………………

Appendix I.

Letter of consent – parent (retrospective data from 2012 and 2013)

School of Education
GPO Box 2100
Adelaide SA 5001

CRICOS Provider No. 00114A

PARENTAL CONSENT FORM FOR CHILD PARTICIPATION IN RESEARCH
CONSENT FORM FOR PARTICIPATION IN RESEARCH
(By participation in the programme)

I ………
being over the age of 18 years hereby consent to my child ……………………………………participating, as requested, in the Letter of Introduction for the research project on
'The Effects of a Sensory Integration Programme on behaviours of students with autism- task engagement, social interactions and emotional crises'.

1. I have read the information provided.
2. Details of procedures and any risks have been explained to my satisfaction.
3. I agree to allow the researcher to obtain and analyse documentary data and video tapes of my child when he/she was first introduced to the sensory integration programme at school during the years 2012/2013.
4. I am aware that I should retain a copy of the Information Sheet and Consent Form for future reference.
5. I understand that:
    - My child may not directly benefit from taking part in this research.
    - My child is free to withdraw from the project at any time and is free to decline to answer particular questions.
    - While the information gained in this study will be published as explained, my child will not be identified, and individual information will remain confidential.
    - Whether my child participates or not, or withdraws after participating, will have no effect on his/her progress in his/her course of study, or results gained.
6. I agree to the video tape being made available to the researcher and one other teaching staff for the purpose of social validation.
7. I agree to view the video clips of my child engaged in a table task and at yard play and complete a questionnaire about it, once it has been explained to me by the research student.
8. I have had the opportunity to discuss taking part in this research with a family member or friend.

Participant's signature……………………………………**Date**……………………

I certify that I have explained the study to the volunteer and consider that she/he understands what is involved and freely consents to participation.

inspiring achievement

Appendix J.

Ethical approval – Department for Education

Strategy and Performance

Level 8
31 Flinders Street
Adelaide SA 5000
GPO Box 1152
Adelaide SA 5001
DX 541
Tel 8226 3828
Fax 8226 1400

DECD CS/13/190-3.10

13 December 2013

Ms Swati Phatak
Modbury Special School
Flinders University
Dampier Avenue
HOPE VALLEY S.A. 5090

Dear Swati

Your project titled *"Effects of a Sensory Integration Programme on behaviours of students with autism-task engagement, social interactions and emotional crises"* has now been reviewed by a senior Department for Education and Child Development (DECD) consultant with respect to protection from harm, informed consent, confidentiality and suitability of arrangements. Accordingly, I am pleased to advise you that your project has been **approved**.

The reviewer for your research project made the following comments:

1. Every child achieves their potential - This research proposal is a continuation of encouraging results of a previous pilot study conducted at Modbury Special School by the researcher. Ms Phatak proposes to research Jean Ayre's theory that children engaging in sensory motor activities on a daily basis enable improved engagement in learning.
2. Excellence in education and care - Ms Phatak, through her research will induct teaching staff into conducting observations of children on task engagement and behaviour using a Sensory Processing Measure. Ms Phatak will use data collected in the Modbury Special School 2011 and 2012 sensory motor program.
3. Connect with communities – Ms Phatak will seek permission from families for this research, has permission of the school principal and will involve training of classroom teachers in appropriate collection of data strategies.
4. A successful and sustainable organisation - Ms Phatak has given permission for research results to be available throughout DECD and will raise awareness of the impact of sensory integration therapy within a special education setting.

Please contact Ms Jenny Paterson, Project Officer - Research and Evaluation on (08) 8226 3825 or email: jenny.paterson3@sa.gov.au for any other matters you may wish to discuss regarding the general review/approval process.

Please supply the department with an electronic copy of the final report which will be circulated to interested staff and then made available to DECD educators for future reference.

I wish you well with your project.

Dr Mark Witham
DIRECTOR, RESEARCH AND EVALUATION

Appendix K.

Ethical approval – SBREC, Flinders University

FINAL APPROVAL NOTICE

Project No.:	**6320**
Project Title:	Effects of a Sensory Integration Programme on behaviours of students with autism- task engagement, social interactions and emotional crises
Principal Researcher:	Mrs Swait Phatak
Email:	Phat0003@flinders.edu.au

Approval Date:	18 December 2013	Ethics Approval Expiry Date:	**31 December 2014**

The above proposed project has been **approved** on the basis of the information contained in the application, its attachments and the information subsequently provided.

MODIFICATION (No.2) APPROVAL NOTICE

Project No.:	**6320**
Project Title:	Effects of a Sensory Integration Programme on behaviours of students with autism- task engagement, social interactions and emotional crises
Principal Researcher:	Mrs Swait Phatak
Email:	Phat0003@flinders.edu.au

Modification Approval Date:	4 May 2018	Ethics Approval Expiry Date:	**31 December 2018**

I am pleased to inform you that the extension of time / ethics approval expiry date request submitted for project 6320 on the 3 May 2018 has been reviewed and approved by the SBREC Executive Officer.

Approved Modification	
Extension of ethics approval expiry date (ONLY)	X