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ORIGINAL PAPER

Comparison of Behavioral Intervention and Sensory-Integration Therapy in the Treatment of Challenging Behavior

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Abstract The objective of the current study was to compare the effects of sensory-integration therapy (SIT) and a behavioral intervention on rates of challenging behavior (including self-injurious behavior) in four children diagnosed with Autism Spectrum Disorder. For each of the participants a functional assessment was conducted to identify the variables maintaining challenging behavior. Results of these assessments were used to design function-based behavioral interventions for each participant. Recommendations for the sensory-integration treatment were designed by an Occupational Therapist, trained in the use of sensory-integration theory and techniques. The sensory-integration techniques were not dependent on the results of the functional assessments. The study was conducted within an alternating treatments design, with initial baseline and final best treatment phase. For each participant, results demonstrated that the behavioral intervention was more effective than the sensory integration therapy in the treatment of challenging behavior. In the best treatment phase, the behavioral intervention alone was implemented and further reduction was observed in the rate of challenging behavior. Analysis of saliva samples revealed relatively low levels of cortisol and very little stress-responsivity across the SIT condition and the behavioral intervention condition, which may be related to the participants' capacity to perceive stress in terms of its social significance.

Keywords Autism · Challenging behavior · Behavioral intervention · Sensory-integration therapy · Cortisol · Stress-responsivity

Introduction

Developing interventions for challenging behavior is often a primary responsibility for professionals working with persons with developmental disabilities. These behaviors often make it difficult to implement instructional programming, prohibit inclusion into less restrictive environments, and may also cause injury to the individual engaging in the behavior or others in their immediate environment. For these reasons, developing effective interventions is imperative to maximising opportunities and improving quality of life for these individuals. The most effective and empirically validated interventions developed to date have been based on operant conditioning principles (e.g. Bachman 1972; Marcus and Vollmer 1996; Mason and Iwata 1990; Vollmer et al. 1993; Borrero and Vollmer 2006). The literature on this topic, however, reflects many divergent theories regarding how challenging behavior, particularly self-injurious behavior (SIB) are viewed and consequently how they are treated. These include sensory-based interventions such as Sensory-Integration Therapy (Ayres 1972a) and Auditory-Integration Training (Mudford et al. 2000); alternative medical systems such as homoeopathy, biologically based therapies such as herbal medicine and secretin (Horvath et al. 1999) and various dietary regimens such as gluten and casein free diets (Lucarelli et al. 1995)

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One of the most prevalent of these interventions reported and the most commonly applied is Sensory-Integration Therapy (SIT). Interventions based on SIT are widely used among therapists working with children with developmental, learning and behavioral problems (Watling et al. 1999; Case-Smith and Miller 1999; National Board for Certification in Occupational Therapy 2004; Roley et al. 2001; Spitzer et al. 1996). For example, a survey of Occupational Therapists revealed that 82% of respondents reported that they "always" use a sensory integrative approach when working with children with autism (Watling et al. 1999). Parents of children with autism in applied behavior analysis programmes were surveyed on their use and perceptions of supplemental treatments. Results from this study indicated that 56% of respondents had their children exposed to sensory-integration techniques (Smith and Antolovich 2000).

The fundamental postulates of SIT have been well described and discussed in detail (e.g. Ayres 1972b, 1979; Clark and Shuer 1978; Fisher and Murray 1991; Ottenbacher and Short 1985). The theory, on which SIT is based, was first introduced by Ayres (1972a, b) as the "neurological process that organizes sensation from one's own body and from the environment and makes it possible to use the body effectively within the environment" (p. 11). Subsequent authors have referred to problems with sensory integration as "the inefficient neurological processing of information received through the senses, causing problems with learning, development and behavior" (Stock Kranowitz 1998, p. 292). SIT is purported to help children with sensory-integration dysfunction to change how the brain processes and organizes sensations by providing sensory stimulation (Ayres 1979).

Some researchers believe that children with autism and other developmental disorders are hypersensitive or hyposensitive to sensory input (Cook 1990). Therefore, many symptoms associated with autism are conceptualized by SIT proponents as behaviors that are caused by sensory abnormalities. For example, aberrant or maladaptive behaviors have been reinterpreted in light of SIT and are commonly thought to be sensory driven (Chu and Green 1996).

According to SIT, people with autism may experience problems integrating information from the vestibular, proprioceptive and tactile systems. The vestibular system provides sensory input to the brain about the body's movement through space. Signs of vestibular impairment include poor posture and difficulties in planning and sequencing motor activities. The proprioceptive system provides sensory input for muscles and joints. Impairment to this system is said to be manifested by stereotyped body movements such as repeatedly hand-flapping. Impairments in the tactile system are shown by lack of sensitivity or over-sensitivity to sensory stimuli. SIT is designed to restore effective neurological processing by enhancing each of these systems. The application of a "sensory diet" is a common clinical practice by sensory-integration therapists and can involve individualized programs to ameliorate the sensory needs of the individual (see Alhage-Kientz 1996). Sensory stimulation is typically provided in activities such as rocking, jumping on a trampoline, swinging, rolling and riding on scooter boards. Other activities involve the delivery of "deep pressure", "joint compression", and body brushing. In addition, the use of weighted vests, oral motor exercises and body massage are all said to alter and improve arousal states (Wilbarger 1995). Because of the potentially dangerous effects of challenging behavior, and as SIT treatment sessions are costly and often last more than 1 year, further evaluation of the efficacy of sensory integration treatment approaches is important from ethical, financial, and rehabilitative points of view.

A vast body of literature exists that addresses outcomes, efficacy, or effectiveness of the sensory integration approach. For example, Daems (1994) compiled reviews of 57 outcomes studies published between 1972 and 1992 that evaluated interventions based on sensory-integration theory. More recently, Vargas and Camilli (1998) provide a meta-analysis of 32 SIT studies across various diagnoses. The review demonstrated that well-designed rigorous studies demonstrated that SIT did not benefit individuals receiving the intervention. Miller (2003) reported finding more than 80 articles that address sensory integration outcomes. Despite the availability of outcome studies published over the past 30 years, evidence of the effectiveness of this intervention remains inconclusive. Yet, practitioners using the SIT approach report three types of benefits: (a) enhanced ability to focus on relevant materials in educational, therapeutic, and social environments (Wilbarger and Wilbarger 1991); (b) reduction in the rate of aberrant behaviors such as self-injury (Bright et al. 1981) and (c) generalized improvements in nervous system functioning, reflected in gains in higher cognitive activity such as language and reading (Ayres 1979; Magrun et al. 1981). Conversely, inspection of the research to date reveals there is no scientific basis for these assertions (Arendt et al. 1998).

Lemke (1974) presented an uncontrolled case study in which a self-injurious client was exposed to multiple forms of stimulation (e.g. finger massage and ice to the mouth, tooth-brushing, towel massage to the arms, feet slapping and body rolling). Quantitative measures were not a feature of this study and the author simply noted that the subject was freed from restraint. In addition, a study conducted by Bright et al. (1981), applied vestibular, tactile and social stimulation (rocking in a hammock, stroking the back, and holding in a rocking chair while providing social

interaction). The authors reported that the frequency of SIB exhibited decreased during treatment sessions. No objective, quantitative measures were reported in the study. Wells and Smith (1983) provided similar types of sensory stimulation as Bright et al. (1981) as a treatment for SIB. Results from this study indicated that, compared to baseline, the frequency of SIB decreased during therapy sessions.

The studies described present with a number of methodological difficulties that prevent clear interpretation of the reported data. None of the studies provided adequate measurement or assessment of interobserver agreement, and only one of the three studies described, presented data from a baseline condition (Wells and Smith 1983). In addition, in each of the studies described there was a confound of the independent variable. Clients were not exposed to physiological stimulation alone. Instead, physiological stimulation was presented concurrent with other variables, most notably social stimulation. Therefore, there is no clear understanding of exactly which variable was responsible for the improvement in behavior.

Furthermore, studies that reported comparison to a control condition have found little support for the efficacy of SIT for treating children with various developmental disabilities. Iwasaki and Holm (1989) found no difference between the SIT and control condition in decreasing stereotypic behaviors in young children and adults with mental retardation. In another investigation, Densem et al. (1989) found no differences between SIT and no-treatment control conditions for children with learning disabilities.

Dura et al. (1988) reported one of the first controlled evaluations of SIT that showed positive results. The authors used a multielement design to evaluate the effects of SIT on self-injury in an individual with mental retardation. Dura et al. (1988) compared the effects of vestibular stimulation (movement back and fourth on a swing while the client sat on the therapist's lap) with those of a control condition in which the client accessed attention but did not receive any vestibular stimulation. Results from this study showed no incidents of SIB during the sessions containing vestibular stimulation and variable rates of SIB during the control sessions with attention only.

From a behavioral perspective SIB may be developed and maintained through positive, negative and automatic reinforcement. Therefore, SIB that is related to environmental contingencies, such as attention, may be affected by coincidental features of SIT such as non-contingent attention. SIB maintained by escape from demands may also show a decrease during sensory-integration sessions merely as a function of reduced aversive stimulation through withdrawal of demands. Therefore additional research is needed to clarify these issues.

Mason and Iwata (1990) compared the effects of SIT and a behavioral intervention within a multiple-baseline across subjects design. Functional analysis data indicated that SIB for the three participants was maintained by positive reinforcement (Participant 1), automatic reinforcement (Participant 2) and negative reinforcement (Participant 3). SIB for all subjects was only reduced when the behavioral interventions were applied. The data generated from this investigation raises questions about the active components of SIT and the functional types of SIB for which it might be appropriate. Leong and Carter (2008) conducted a comprehensive review of the research on the efficacy of sensory-integration therapy from 1994 to 2007. Their findings demonstrated a lack of solid evidence to support the use of SIT. The authors conclude that the continued use of SIT given the lack of evidence for its effectiveness is not justified. Some have indicated that SIT may be a promising treatment for challenging behavior, including SIB. This conclusion, however, is not based on adequately controlled research (Bright et al. 1981; Dura et al. 1988; Lemke 1974; Wells and Smith 1983; Vargas and Camilli 1998; Leong and Carter 2008). Examination of the available literature on SIT indicates that at present, there is no consistent agreement regarding the effectiveness of sensory integration. Studies have indicated that SIT is ineffective and that its theoretical underpinnings and assessment are not validated (Arendt et al. 1998). This can obviously have detrimental effects for the client presenting with challenging behavior.

In a more recent study, Devlin et al. (2009) investigated the comparative effects of SIT and a behavioral intervention on rates of self-injurious behavior (SIB) in a nine-year-old boy with a diagnosis of autism. Functional analysis data demonstrated that SIB was maintained by negative reinforcement as a result of escaping or avoiding demand situations. SIT and a behavioral intervention were compared within an alternating treatments design. Results from this study demonstrated that the behavioral intervention was more effective in reducing SIB than the SIT. Finally, in the best treatment phase, the behavioral intervention only was implemented and further reduction was observed in the frequency SIB.

It has long been noted that disturbances in the hypothalamic-pituitary-adrenocortical (HPA) axis, part of the limbic system, may be implicated in autism due to its association with emotional regulation and social interactions (Lam et al. 2006). Consistent with this view, a number of studies have appeared to indicate impaired HPA function in children with autism (e.g., Hrdlicka et al. 2005), with several studies indicating abnormalities in the HPA-axis's production of hormones such as cortisol

(e.g., Corbett et al. 2006, 2008; Marinović-Ćurin et al. 2003; Richdale and Prior 1992). Autism has also been linked with abnormalities in circadian patterns of cortisol (e.g., Marinović-Ćurin et al. 2008). However, several studies have indicated no particular autism-related abnormality in either cortisol levels (Jansen et al. 2000; Nir et al. 1995; Sandman et al. 1991; Tordjman et al. 1997; Vedhara et al. 2000) or daily cortisol patterns (Brosnan et al. 2009). It is notable that HPA-mediated production of cortisol is a fundamental part of the human stress response (Vedhara et al. 2000). In this context, some researchers have suggested that cortisol might offer a useful means of assessing mental stress responses in children with autism (Jansen et al. 2003), especially given that autism is typically associated with difficulties in the verbal expression of emotion.

The current investigation extends previous research by examining and comparing the effects of SIT and a behavioral intervention on rates of challenging behavior in 4 children with autism. The study was conducted within an alternating treatments design, with initial baseline and final best treatment phase. Saliva samples were gathered daily for the duration of the alternating treatments phase to give a measure of cortisol which indicates responsivity to stress during each of the conditions.

Method

Participants

The participants were four males with a diagnosis of Autism Spectrum Disorder. Participants were selected because they each had a history of engaging in challenging behavior, primarily in the form of aggression and self-injury. Each of the participants attended a school using applied behavior analysis as treatment for children with autism five days per week, for six hours per day. Participants also received Speech and Language therapy and Occupational therapy within their placement. School and parental consent for full participation was obtained prior to the onset of the study.

Participant 1 was 6:7 year old boy at the beginning of the study. He was diagnosed with Autism Spectrum Disorder at 2 years 2 months by an independent clinical psychologist. His score on the Gilliam Autism Rating Scale (GARS) indicated a mild degree of severity of autism. The participant had difficulty with receptive and expressive language. He responded to familiar instructions and primarily used 3 word sentences to communicate his needs. The participant presented with a history of aggression and self-injury, which included typographies such as kicking, hitting, crying, head-hitting and stamping feet. Occurrences of these behaviors were observed in both home and school settings.

Participant 2 was an 11 year old boy. At the age of 3 years and 4 months, he received a dual diagnosis of Autism Spectrum Disorder with a mild-moderate learning difficulty (motor clumsiness, problematic social relationships, auditory processing problems and poor organizational skills) by an independent clinical psychologist. The participant presented with limited verbal skills, particularly verbal comprehension. His assessment profile indicated strengths in the area of visual spatial skills. His main form of communication was sign language, though he also sometimes used intelligible vocalisations to request items. He had approximately 100 mastered signs in his repertoire which he used fluently. The participant was fully independent with regard to feeding, toileting, dressing and other self-care skills. It was reported by parents and staff that the participant emitted problem behaviors, such as stamping feet, crying, body-tensing and forcefully squeezing his hands together in various situations throughout the day. Occurrences of the behavior were observed both in school and home settings.

Participant 3 was a 10:1 year old boy, with a diagnosis of moderate-severe autism with related learning difficulties. This diagnosis was made by an independent clinical psychologist when the participant was aged 3 years and 4 months. The participant was also diagnosed with epilepsy. His daily prescribed medication to help control seizures included 1,200 mg of Trileptal. The participant presented with very limited cognitive and communication skills. He emitted signs to request six preferred reinforcers. The participant required assistance with toileting, dressing other self-care skills. He was receiving a gluten and casein free diet. It was reported by parents and school staff that the participant had a history of SIB (hand-mouthing, hand-biting) that resulted in visible tissue damage. He also emitted behaviors such as hair-pulling and scratching in similar situations. Occurrences of the behavior were observed both at school and at home.

Participant 4 was 9:11 at the beginning of the current investigation. At eththe age of 3 years 3 months, he was diagnosed with moderate-severe learning disability with medical, language and sensory deficits. At 5:7, he was diagnosed with Autism Spectrum Disorder by an independent clinical psychologist. His main form of communication was sign language. He had approximately 30 signs in his repertoire which he used fluently. The participant was fully independent with regard to toileting and feeding. He required some assistance with dressing and other self-care skills. It was reported by parents and staff that the participant engaged in SIB, in the form of biting his fingers in various situations. Occurrences of the behavior were observed both in school and home settings.

All four participants were diagnosed with autism using the Gilliam Autism Rating Scale and the Childhood Autism

Rating Scale along with the DSM-IV criteria for Autism Disorder. No participants were taking any psychotropic medication.

Setting and Apparatus

The alternating treatment sessions and the best treatment phase of the investigation were conducted primarily in the participants' regular classrooms. Some techniques were conducted in an occupational therapy room within the school.

Sensory Integration Therapy Equipment

A net swing was used measuring 78″ × 39″ and was hung from a bar structure on the ceiling with a safety snap and a heavy duty rotational device. A trampoline measuring 14′ diameter × 36″ high with a safety enclosure surrounding surface area was also used. A therapy ball measuring 21″ in diameter and a 16″ 'peanut' shaped ball made from durable, heavy-duty molded vinyl were used. Other equipment included a beanbag made from polystyrene beans and foam pieces, a blanket made from lycra and a 'T' shaped 'chewy tube' oral motor device which provided a chewable surface for biting and chewing skills. Smaller beanbags (4″ × 4″) were used for 'tapping' activities. A surgical brush was used with soft bristles on one side and a sponge on the other side.

Other equipment used throughout the investigation included standard salivettes (Kirschbaum and Hellhammer 1994), which comprise 2-inch cotton rolls packaged in polypropylene vials, for collection of saliva. The salivettes were labelled and stored in a small durable cardboard box in a freezer. Digital count-down timers were also used.

Measures

Daily Frequency of Challenging Behavior

Frequency data, (no. of incidents per day) was taken for each of the four participants, for both SIT and the behavior intervention conditions. Because each participant presented with self-injurious behavior, attempts to engage in this behavior were physically blocked and were recorded as an incident. A start/stop definition of the target behaviors was defined as a 5 s break between each occurrence before another incident was recorded. Pen and paper were used to record the occurrences of the target behaviors for each participant.

Behavioral Function Measures

The *Questions About Behavioral Function (QABF)* is a rating scale administered to determine the function of challenging behaviour. The QABF (Matson and Vollmer 1995) is an indirect assessment of behavioral function that consists of 25 questions. Each question is scored along a four point scale with frequency descriptors of Never, Rarely, Some and Often. The test yields summary statistics for five categories reflecting the behavioral functions of escape, attention, physical, tangible and non-social. The function of a particular behavior is determined if a total subscale(s) score is significantly greater than other subscale scores. The assessment is administered in an interview format to a respondent who is familiar with the person. The *Functional Assessment Screening Tool- Revised (*The FAST-R; Iwata and DeLeon 1995) is a 20-item questionnaire designed to identify contingencies of reinforcement that maintain aberrant behavior. This assessment is organized so that each question corresponds with 1 of 4 possible categories of maintaining contingencies: social positive reinforcement in the form of attention and/or preferred items, social negative reinforcement in the form of escape from task or demands, automatic positive reinforcement in the form of sensory stimulation, and automatic negative reinforcement in the form of pain attenuation. Five questions are allocated to each category and each question is answered in a Yes/No format. A point is awarded for every 'Yes' response given by the respondent. The points are summed for each category. The category receiving the most points is considered the hypothesized maintaining variable.

Stress Measure

Salivary cortisol samples were taken to measure stress levels. Baseline samples were taken over 2 consecutive days during school holidays when no intervention was in place. During the alternating treatments phase of the investigation, where the behavioral intervention and SIT intervention were alternated across daily sessions, samples were collected three times per day (10 AM, 12:30 PM, 2:30 PM).

Salivary cortisol has emerged in paediatric research as a reliable biologic marker of stress. Cortisol can be used to assess responses to stressful stimuli or to determine the effectiveness of interventions intended to reduce stress (Hanrahan et al. 2006). Researchers have developed methods for collecting salivary cortisol in children, and recent lab techniques have made it possible to detect very small concentrations of cortisol in plasma and saliva.

In the current study, salivary cortisol was collected from three of the participants (one of the participants was not comfortable with having the sailvette in his mouth for the required period of time, and thus was excluded from the analysis). Saliva was collected for analysis using standard salivettes, each consisting of a plain cotton swab packaged

in a polypropylene vial. Measurement of salivary cortisol using absorbent cotton materials to collect saliva is considered trouble-free, given the stability of cortisol levels in saliva (Kirschbaum and Hellhammer 2000; Garde and Hansen 2005). Further, as alternative methods would require the repeated drawing of blood samples from participants, it was considered that the use of salivettes represented a suitably non-invasive and user-friendly method for researching the present population. Participants were introduced to swab usage 3 weeks prior to the commencement of the study to acclimatize them to the collection procedure. Collection was closely supervised and timed for all samples taken throughout the course of this study. Participants were instructed to place the salivette in their mouths for 80 s, timed precisely by the researcher using a portable digital timer. When the time had elapsed, the salivette was removed and placed in its vial and labelled with the participant's name, the time, the date and the intervention in place on that day. The salivette was then put upright in a cardboard box and stored in a freezer at −30°C until assay. Participants took the Salivette 3 times per day at exactly the same time each day. As certain foods and drinks have been reported to affect salivary cortisol measures, these were avoided for at least 30 min prior to the sample collection.

The samples were thawed to room temperature and centrifuged at 3,000 rpm for 15 min prior to assaying. The saliva samples were analysed for cortisol content using high sensitivity enzyme immunoassay kits (Salimetrics LLC, State College, Pennsylvania), designed specifically for use in research settings.

Samples were analysed in duplicate to ensure accuracy of results, and to reduce intra-assay error variance, all samples for each participant were analysed together. MikroWin 2000 (Mikrotek Laborsysteme GmbH, Germany) data reduction software was used to analyse the results.

Experimental Design

The study was conducted in the format of an alternating treatments design with initial baseline and final best treatment phase. SIT and the Behavioral Interventions were alternated across daily sessions. The sequence of treatments was randomized for each of the participants.

Response Definitions

Operational definitions were developed for each of the participant's target behaviors. For Participant 1, hitting self was defined as forceful contact of the hand or fist against any part of the head. Hitting others was defined as forceful contact of the hand or fist against any part of another person's body. Kicking was defined as any forceful contact of the foot with another part of a person's body. Stamping feet was defined as any instance of forceful contact with the floor using the sole of either foot to make a noise. Crying was defined as any instance of unintelligible audible vocalizations accompanied with tears and clapping hands was defined as any forceful contact of open palms of both hands with each other.

For Participant 2, crying was defined as any instance of unintelligible audible vocalizations accompanied with tears. Feet stamping was defined as any instance of forceful contact with the floor using the sole of either foot to make a noise. Body tensing was defined as any instance of the following together or in isolation: sudden tensing of the face with jaw clenching, sudden body rigidity or flicking of hand and arm in downward motion to rigid state. Squeezing hands was defined as any instance of the following: palms of both hands making contact, with fingers interlocked or clasped around the back of the hand with force.

Target behaviors for Participant 3 were hand-mouthing which was defined as insertion of one or more fingers or partial area of the back of the hand past the plain of the lips or into the mouth; hand-biting which was defined as closure of the upper and lower teeth on the flesh of any portion of the hand or fingers; scratching was defined as movement of hand and fingers making contact with the body parts of another person and hair pulling was defined as the closure of the fingers and thumb on hair of another person with a pulling motion away from the head.

The target behavior identified for Participant 4 was finger-biting and was defined as contact of the teeth with any part of the fingers.

Phase 1: Functional Assessments

Functional assessments were conducted prior to the alternating treatments phase of the investigation to determine the function of challenging behaviors for each of the participants. Participants 2 and 3 received an experimental functional analysis, Participant 1 received the Questions About Behavior Function (Matson and Vollmer 1995) and Participant 4 received the FAST-R (Iwata and DeLeon 1996). Consequently, individual behavioral interventions were designed based upon results obtained from these assessments.

The experimental functional analysis conducted was based on the format described by Iwata et al. (1994). Both participants (2 & 3) were exposed to five conditions (demand, attention, access to tangible items, alone and play) each presented during 10 min sessions within a multielement design. For the most part, the sessions took place in a small behavioral observation room. The procedures employed within each of the conditions are described as follows.

Attention Condition

During this condition the experimenter directed the participant to a variety of toys in the room and subsequently sat in another corner of the room and assumed the appearance of reading a book. Attention, in the form of a reprimand or expressions of concern, was delivered for approx 3–5 s contingent on the occurrence of target responses. This condition was included to approximate one type of reinforcement contingency that may be maintaining target responses.

Access to Tangible Items

The participant was provided with access to preferred tangible items just before beginning the session. When the session began, the tangible stimuli were removed from reach but were in view of the participant. Contingent on occurrences of target behavior, access to the tangible stimuli was permitted for 15 s. The purpose of this condition was to test for a behavioral sensitivity to positive reinforcement by tangible stimuli.

Demand

During this condition, the experimenter was seated beside the participant and gave a verbal instruction to complete an academic task. The experimenter gave the participant 5 s to start the task. If after 5 s he did not respond, the experimenter repeated the verbal instruction and used a three-prompt sequence (verbal, touch or model, physical guidance) to assist the participant to follow through with the instruction. Contingent on the occurrence of the target behaviors at any time during the instructional sequence, the experimenter immediately terminated the trial and turned away from the participant for 30 s. The experimenter continued with academic demands for 10 min.

For Participant 2, this condition included some adaptations to the original procedure described above. Information from descriptive analyses (ABC data) suggested that target behaviors may be maintained by task demands which required the participant to transition to another part of the room. Therefore, demands were placed which required the participant to complete an academic task at a table and also to complete an academic task which first required the participant to transition. These demands were mixed and varied throughout the session. Demands to comply with the task demand were immediately withdrawn for 30 s contingent on occurrence of the target responses. The differential effects of these two types of demands were further analysed in an ABAB reversal design. This condition was included to assess whether target behaviors were maintained by negative reinforcement as a result of escaping or avoiding demand situations.

Alone Condition

The participant was in the experimental room without access to preferred stimuli or attention. Target behaviors were not followed by any programmed consequences. The purpose of this condition was to test whether behavior occurred at higher rates in a relatively austere environment and in the absence of social contingencies.

Play Condition

The participant was provided with continuous access to preferred stimuli. Also, attention was delivered on a fixed-time (FT) 30-s schedule (occurrences of the target behaviors within 5-s of scheduled attention delayed the delivery of attention until 5-s elapsed with no occurrence of the target behavior). No instructional demands were presented. This condition served as a control for the aforementioned test conditions.

Functional analyses sessions were conducted in a therapy room with an observation window. This room contained a table, two chairs and appropriate materials for each analogue condition. For Participant 3, some of the functional analysis sessions were conducted in the participant's regular classroom. A dictaphone was used to signal the end of each 10 s recording interval. An interval observation recording sheet and pen were used to score all target behaviors.

For Participant 3, three of these conditions (control, demand, and access to tangible items) were further analysed in the participant's classroom in order to rule out any potential effects of the analogue setting.

Phase 2: Alternating Treatments Phase with Initial Baseline

Baseline

For each of the participants, frequency data was taken on challenging behaviors prior to the introduction of either intervention. Target behaviors were observed and recorded across 5 consecutive daily sessions.

Alternating Treatments

To compare the differential effects of the sensory-integration therapy and the behavioral intervention on rates of challenging behavior, an alternating treatments design was implemented across 10 daily sessions (see Table 1).

Table 1 Sequence of interventions during the alternating treatments phase of the experiment

Participants	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
1	SIT	SIT	BI	BI	SIT	SIT	BI	A	A	A
2	BI	SIT	SIT	BI	BI	SIT	BI	BI	SIT	SIT
3	SIT	BI	SIT	BI	BI	SIT	SIT	BI	A	A
4	BI	SIT	SIT	BI	BI	SIT	SIT	BI	BI	SIT

SI Sensory-integration therapy, *BI* behavioral intervention, *A* absent

Function based behavioral interventions were designed based on the results of the functional assessments conducted during Phase 1. SIT interventions were based on available literature and were designed by an Occupational Therapist (OT) who was familiar with the participants and who had completed direct observation of each participant over a period of one month. The OT was fully trained in designing and implementing SIT procedures. SIT interventions for all participants were designed independent of the results of the functional assessments. Throughout the experiment, the OT was available to provide supervision and feedback to staff members to ensure that interventions were tailored to participants' needs. To ensure safety for both the participant and staff members, a cut-off point was established for the target behaviors. Contingent on the target behavior reaching this pre-specified criterion level, the therapy was discontinued for that particular session. The participants' safety was ensured and no further requests were placed.

Sensory Integration Therapy

For each of the four participants a 'sensory diet' was recommended based on techniques that would facilitate vestibular, proprioceptive and tactile input along with Wilbarger's (1995) joint compression and brushing. Vestibular input included swinging on a net swing, jumping on a trampoline, rocking and rolling on a peanut-shaped ball. Proprioceptive input involved wrapping the participant in a lycra blanket and pressing a large ball on the body to deliver deep pressure along with crawling using elbows on a soft mat. Tactile input involved tapping areas of the body with a light bean bag. Oral-motor control included chewing on a chewy tube and massage of the lips and cheeks. Joint compression was delivered by manually compressing shoulders, elbows, wrists and hips. During this condition, a session was defined as a school day comprising of 6 h. Each participant was provided with access to each of the sensory-integration activities and equipment for 15 min prior to desktop activities across the school day (approx. 6 times per day) or contingent on the emission of the target behavior. In this condition, during table-top activities, each participant was provided with non-contingent breaks every 5 min. During the school day students worked on individualised programs from various curricula areas including communication, academic, problem-solving, social, leisure and self-help. A typical school day involved a 30 min snack break and a 45 min lunch break. Students spent time working in small group instructional sessions within and outside of their classrooms. Each student had an individualised time-table that designated their sequence of programs and activities across the session. The teaching methods were all drawn from the literature on Applied Behavior Analysis and included strategies such as shaping, errorless learning, discrete trials, personalised system of instruction, direct instruction and behavior momentum.

Behavioral Intervention

During this condition, a session was defined as a school day comprising of 6 h. Students followed their individualised time-tables and the function-based behavioural interventions were implemented across the entire session. Interventions that increased schedules of reinforcement or provided replacement skills training were incorporated into the students' program plan and interventions that were contingent on the occurrence of challenging behavior were implemented consistently across the session.

Participant 1: Behavioral Intervention

Results from the functional assessment (QABF) suggested that problem behavior was maintained by negative reinforcement as a result of escaping or avoiding demand situations and by positive reinforcement in the form of accessing preferred tangible items. Based on these results a function-based behavioral intervention was designed and implemented.

Interspersal of Requests and Fast-Pace Instruction

During intensive teaching sessions (i.e., multiple tasks presented in massed trial table-top instruction), mastered and fluent operants were interspersed among trials of more difficult demands containing acquisition tasks. These

demands were delivered in a fast-paced manner (inter-trial interval 1 s). This component of the intervention was implemented to increase the probability that the participant would attempt to perform new or difficult tasks without engaging in problem behavior (Horner et al. 1991).

Variable Schedule of Reinforcement

During intensive teaching sessions, academic materials (e.g., puzzles, matching tasks) were presented with a verbal instruction to complete the task. If the participant responded correctly within 2 s, verbal praise was delivered. Tangible items were delivered on a VR6 schedule (i.e. every sixth consecutive correct response). The tangible items consisted of access to a DVD player for up to 1 min or preferred edibles. If an error was recorded or no response occurred after a period of 2 s, the experimenter restarted the trial and used an errorless learning procedure to obtain correct responding.

Errorless Learning

Student errors were reduced through teaching procedures that ensured high levels of correct responding. Time delay prompt procedures were used, where the prompts functioned as antecedents to responses as opposed to consequences for incorrect responses. The time delay extended from 0 s to short durations of 2–3 s to avoid errors, therefore establishing a higher density of reinforcement for quick and correct responding.

Extinction and Differential Reinforcement

Contingent on any attempt to engage in challenging behaviors during an instructional trial, the experimenter physically blocked the response, averted eye contact, and redirected the participant to the task. Increased gestural or verbal assistance was provided to obtain correct responding. Following compliance with the initial demand, a digital timer was set and demands were delivered for a duration of 2 min. At the end of the 2 min demand session, a less preferred reinforcer was offered. Contingent on appropriate responding thereafter, the participant's access to preferred tangible items was dictated by a reinforcement hierarchy (from least to most reinforcing).

Positive Practice Over-Correction

Contingent on the target behaviors occurring at any other time during the school day (e.g. in playground, at lunch, playing with toys), the participant was redirected to an effortful task (e.g. placing small pegs in container, threading beads, threading boards) for 2 min.

Differential Reinforcement of an Alternative Response

The objective of this element of the behavioral intervention was to train appropriate responding in situations where the participant was denied access to preferred items. A training trial was initiated when the student emitted a mand or showed strong motivation for an item or activity. The procedure initially involved a situation where the experimenter denied the participant access to a preferred item and immediately offered a tangible item of equal value. The alternative response which was reinforced was the participant accepting the other preferred item offered, saying 'no thank-you' or 'no, I don't want it'. If any problem behavior occurred during the trial, extinction was used and the participant lost the opportunity to gain access to the reinforcer. The alternative reinforcer was removed from view and the participant was redirected to a less preferred task. Each day, multiple practice opportunities were contrived to give the participant repeated exposures to the contingencies. The preference level of the alternative reinforcer was gradually faded from equally preferred, slightly less preferred, neutral stimulus to a point where no alternative was offered.

Participant 2: Behavioral Intervention

Results from the functional analysis indicated that problem behavior was maintained by negative reinforcement as a result of escaping or avoiding demand situations. Further analysis of antecedent variables, showed relatively high rates of responding in situations where the participant was required to transition prior to completing task demands. Considering these results a reinforcement based treatment package was designed to correspond to the operant function of the participant's problem behaviors.

Differential Reinforcement of Alternative Behavior (DRA) and Extinction

During this condition, the participant earned access to a preferred reinforcer (e.g. book, edibles) contingent on appropriate transition behavior. This component of the intervention was included to strengthen competing behavior (Lalli et al. 1999). The experimenter initiated the transition trial by saying "Let's go sit over here". The instructor remained within 2–3 feet of the participant so that prompts and physical guidance could be given where necessary. Initially, the reinforcer was delivered after each successful transition (FR1). This schedule was faded gradually over time. Contingent on the occurrence of the target behavior, escape extinction was used (Iwata et al. 1990). The participant immediately lost the opportunity to access the reinforcer and the experimenter persisted with the original

demand. Guidance was used where necessary and all attempts to engage in the target behaviors were blocked.

Demand Fading

The number and difficulty of demands presented following appropriate transition behavior was increased gradually, in accordance with pre-specified criteria. The number of demand trials that the participant was required to complete after transitioning was increased by one after two consecutive days (approx 20 contrived opportunities per day) in which 90% of the transitions recorded were successful (i.e. no occurrence of the problem behavior was recorded across 90% of trials).

Participant 3: Behavioral Intervention

Results from the functional analysis, demonstrated that the target behaviors were maintained by negative reinforcement in the form of escape from task demands and positive reinforcement in the form of access to tangible items contingent on the target behaviors. The outcome of this analysis was used to design a function-based treatment package to reduce problem behaviors.

Variable Schedule of Reinforcement, Response Blocking and Extinction

During intensive teaching sessions, academic materials (e.g., matching/discrimination tasks) were presented with a verbal instruction to complete the task. If the participant responded correctly within 2 s, verbal praise was delivered. Tangible items were delivered on a VR3 schedule (i.e. approx. every third correct response). The tangible items consisted of small edibles (e.g. crisps). If an error was recorded or no response occurred after 3 s, the experimenter restarted the trial and provided increased physical, gestural, or verbal assistance to obtain correct responding. During group teaching situations, a preferred reinforcer was delivered on a variable interval schedule (VI 7 s) contingent on appropriate sitting and responding. Contingent on the occurrence of the target behavior during a demand situation, the experimenter physically interrupted the self-injurious responses and immediately redirected the participant to the original task presented. Prompt levels were increased to achieve correct responding.

Differential Reinforcement of Alternative Response and Extinction

The objective of this component of the intervention was to teach the participant to 'wait' appropriately when preferred tangible items were not available immediately. This procedure was initiated when the participant emitted a mand for a preferred item. The experimenter said 'you'll have to wait' and began counting aloud. Initially, the specified 'wait' time was 3 s. This time was gradually increased based upon the absence of the occurrence of the target behaviors. If the target behaviors did not occur during the specified 'wait' interval, the tangible item was delivered immediately. If the participant attempted to engage in the target behaviors at any point during the wait interval, the experimenter blocked the responses and said 'you have to wait nicely' and the interval was restarted from zero. If the trial needed to be restarted more than 5 times, the participant lost the opportunity for reinforcement and was redirected to a novel task.

Participant 4: Behavioral Intervention

Results from the FAST-R identified escape from task demands and situations where the participant was denied access to tangible items as maintaining variables for challenging behavior.

Variable Schedule of Reinforcement

During intensive teaching sessions, the experimenter delivered a verbal instruction and the materials required to complete a specified task (e.g., sorting tasks, form box, receptive identification). If the participant responded correctly within 2 s, verbal praise was delivered. Tangible items were delivered on a VR4 schedule (i.e. after approx every fourth response, a reinforcer was delivered). If an error was recorded or no response occurred after a period of 3 s, the experimenter restarted the trial and provided increased physical, gestural, or verbal assistance to obtain correct responding.

Extinction

Contingent on the occurrence of the target behavior during an instructional trial, the experimenter physically interrupted self-injurious responses, and immediately redirected the participant to the task.

Differential Reinforcement of Alternative Responding

The objective of this component of the intervention was to teach appropriate behavior that would match the function of self-injurious responses when the participant was denied access to tangible items. The procedure used was identical to that described for Participant 1. The alternative response that was reinforced was a sign for 'no thank-you' or acceptance of the alternative preferred item offered.

Phase 3: Best Treatment Phase

For each participant, data from the alternating treatments phase of the experiment (Phase 2) demonstrated that the greatest reduction of the target behaviors was observed when the behavioral intervention treatment package was implemented. As a result of the effectiveness of the behavioral intervention during Phase 2, it was implemented alone for eight subsequent and consecutive days.

Interobserver Agreement

During the functional analysis for Participant 2, interobserver agreement was recorded by two observers on an interval-by interval basis for all target behaviors during 48% of the sessions. For Participant 3, two independent observers scored subject responses during all functional analysis sessions (100%). Agreement was calculated by dividing the number of intervals in which observers agreed on the presence or absence of target behavior (agreements) by the number of agreements plus disagreements and multiplying the result by 100% (Bailey and Bostow 1979; Hawkins and Dotson 1975). Mean agreement on target behaviors for Participant 2 was 94% and ranged from 89 to 100%. Average interobserver agreement for Participant 3 across sessions was 97%. During the alternating treatments phase of the experiment, interobserver agreement was recorded by the experimenter and an observer across 20% of sessions for each of the participants. Agreement was calculated by dividing the highest frequency of behaviors by the lowest frequency of behaviors recorded and multiplying by 100. Mean agreement for Participant 1 was 92%, for Participant 2 was 87%, for Participant 3 was 96% and mean interobserver agreement for Participant 4 was 98% across sessions.

Results

Frequency of Challenging Behavior during Baseline, Alternating Treatments and Best Treatment Phase

Figure 1 represents the mean rate of occurrence of challenging behavior observed in baseline, alternating treatments and best treatment phases for each of the participants.

Participant 1

Figure 2 represents the rate of occurrence of challenging behavior during baseline, alternating treatments and final best treatment phases for Participant 1. During the baseline phase, target behaviors occurred at a moderate—high rate

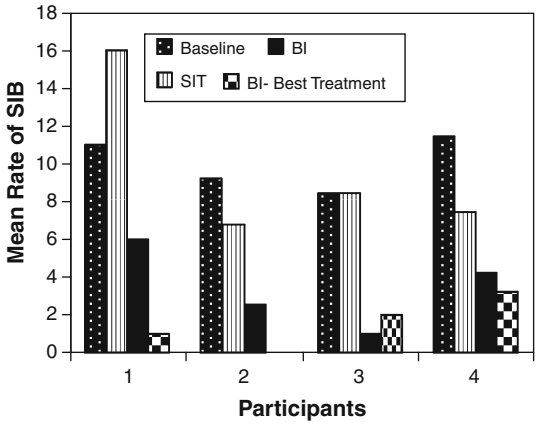

Fig. 1 Mean rate of occurrence of SIB and challenging behavior observed in baseline, alternating treatments and best treatment phases

(mean = 11 incidents per daily session). During the alternating treatments phase, the SIT and behavioral interventions were alternated randomly across 7 daily sessions (Participant 1 absent for three sessions). Generally, the data pattern depicts a lower rate of challenging behavior when the behavioral intervention was in place. On the SIT days, target behaviors were observed to occur at a relatively high rate (mean = 16 occurrences per day). In comparison, on the behavioral intervention days, target behaviors occurred at a much lower rate (mean = 6 occurrences per day). Based on the data from the alternating treatments phase, the behavioral intervention only was implemented in the final phase. During this phase, the rate of challenging behavior decreased further to 1 incident per day on conclusion of the study.

Participant 2

Figure 3 represents the results of the functional analysis for Participant 2, conducted during Phase 1 of the study. This analysis was conducted within a multi-element format and the extended analysis was conducted within a reversal design. Occurrence of challenging behavior is expressed as percentage of 10-s intervals during all experimental conditions—demand, attention, alone, access to tangible items and play. Results demonstrated that the participant displayed the greatest rate of disruptive responses during the demand condition (mean = 20% of 10-s intervals with challenging behavior). Lower levels (mean = 6% of 10-s intervals with challenging behavior) were observed in the condition where access to tangible items was limited. There were no incidents of target behaviors observed during the alone condition or the attention condition. In the extended analysis, the effect of including transitioning trials in the demand condition was explored further in a reversal design. Results from this analysis consistently

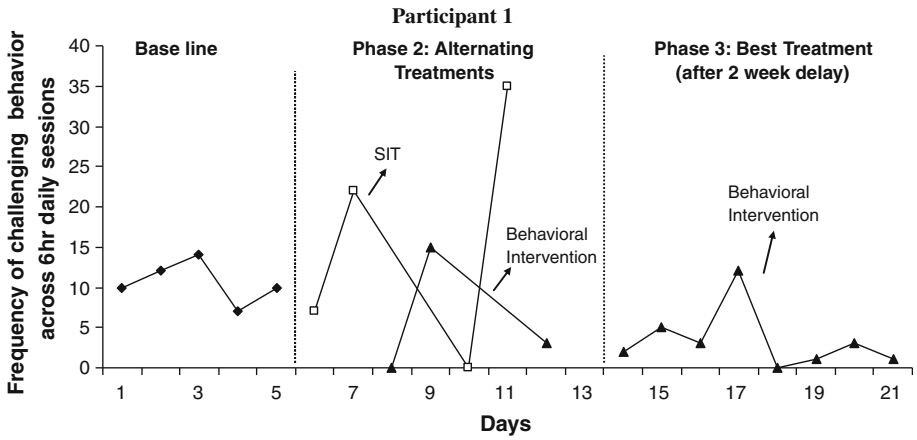

Fig. 2 The rate of occurrence of challenging behavior for Participant 1 during baseline, alternating treatments phase (SIT and behavioral intervention) and final best treatment phase (behavioral intervention alone)

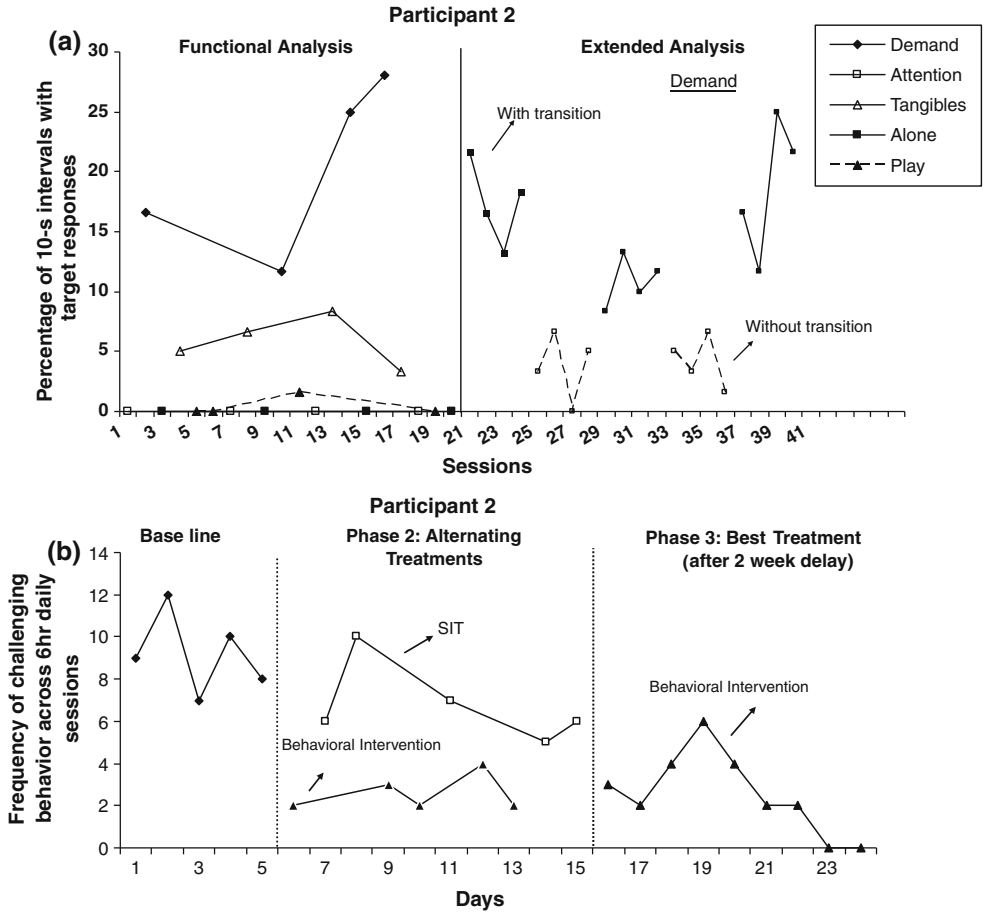

Fig. 3 **a** Percentage of 10-s intervals of challenging behavior emitted during each of the functional analysis conditions for Participant 2. **b** The rate of occurrence of challenging behavior for Participant 2 during baseline, alternating treatments phase (SIT and behavioral intervention) and final best treatment phase (behavioral intervention alone)

showed relatively high levels of responding when the transitioning trials were included (M = 14%), whereas lower levels of the target responses were observed when demands to transition were not included in the session (mean = 3% of 10-s intervals with challenging behavior). This trend is clearly observed across all phases of the reversal design.

Figure 3a, b represents the rate of occurrence of challenging behavior during baseline, alternating treatments and final best treatment phases for Participant 2. An average of 9 incidents per day was observed during the baseline phase. During the alternating treatments phase, SIT and behavioral interventions were randomly alternated across 10 daily sessions. The data pattern clearly indicates

a low rate of challenging behavior on the behavioral intervention days. More specifically, target behaviors were observed to occur at a much higher rated on the SIT days (mean = 6.8) than on the behavioral intervention days (mean = 2.6). In the final best treatment phase, when the behavioral intervention was consistently applied, the rate of occurrence of target behaviors decreased further to 0.

Participant 3

Figure 4 shows the results of the functional analysis for Participant 3. Occurrence of challenging behavior is expressed as percentage of 10-s intervals for the participant during all experimental conditions. Figure 3 illustrates consistently high levels of target behaviors emitted during the demand condition in both analogue and classroom settings. In both settings, moderate to low levels were observed in the condition where access to tangible items was limited. There were no occurrences of SIB in the control, alone and attention conditions.

Figure 4a, b represents the rate of occurrence of challenging behavior during baseline, alternating treatments and final best treatment phases for Participant 3. During the baseline phase, a mean rate of 8.4 target behaviors was observed over 5 daily sessions. Data from the alternating treatments phase demonstrates that the behavioral intervention was more effective for the treatment of challenging behavior than the SIT intervention. In fact, there was no difference in the rate of SIB and challenging behavior between the baseline phase (mean = 8.4) and the rate of target behaviors observed when SIT was in place (8.5). Therefore, the final phase of the study consisted only of the behavioral intervention. At the beginning of this phase, target behaviors occurred at a relatively high rate. This rate was observed to decrease rapidly when the behavioral intervention was consistently applied, with the rate of challenging behavior recorded at 2 incidents per day on conclusion of the study.

Participant 4

Figure 5 represents the rate of occurrence of SIB during baseline, alternating treatments and final best treatment phases for Participant 4. An average of 11.4 incidents per day was observed during the baseline phase. During the alternating treatments the data pattern observed is highly

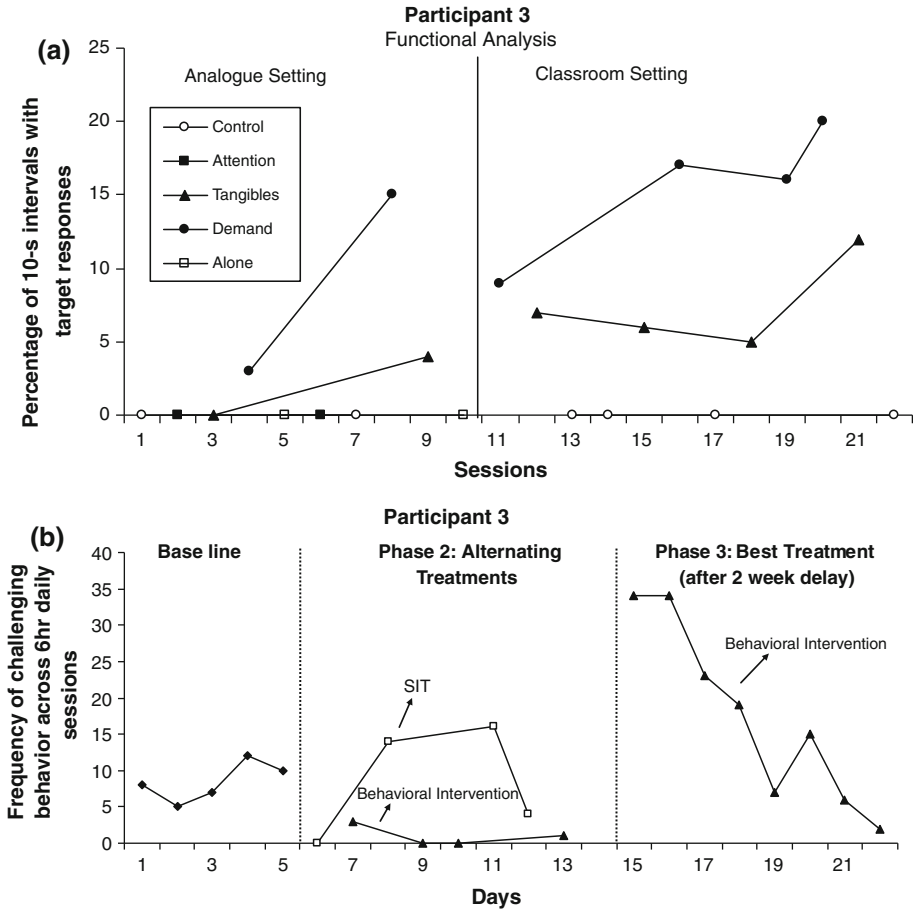

Fig. 4 **a** Percentage of 10-s intervals of SIB and challenging behavior emitted during each of the functional analysis conditions for Participant 3. **b** The rate of occurrence of challenging behavior for Participant 3 during baseline, alternating treatments phase (SIT and behavioral intervention) and final best treatment phase (behavioral intervention alone)

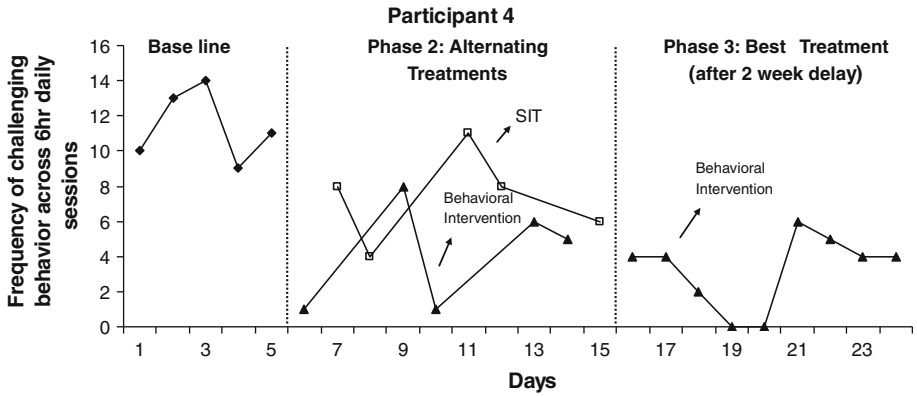

Fig. 5 The rate of occurrence of challenging behavior for Participant 4 during baseline, alternating treatments phase (SIT and behavioral intervention) and final best treatment phase (behavioral intervention alone)

variable for both treatments. However, an overall lower rate of SIB was recorded on days where the behavioral intervention was in effect. A mean occurrence of 4.2 was observed on behavioral intervention days, whereas a mean occurrence of 7.4 incidents was observed on SIT days. Therefore, the behavioral intervention only was applied during the best treatment phase of the investigation. The data pattern from the best treatment phase is highly variable. Although a decreasing trend to 0 occurrences was initially observed, this level increased again to 6 occurrences on day 5 of this phase. On conclusion of the study, 4 incidents of SIB were recorded per day.

Salivary Cortisol Analysis

Table 2 shows overall mean salivary cortisol levels from the samples taken during the alternating treatments phase of the investigation. Baseline cortisol levels (no intervention) are also represented. For Participant 1, mean cortisol levels reported from the analysis were slightly higher during baseline (when no intervention was in place, which may indicate an elevated level of stress in this condition. However, given the relatively large standard deviation during baseline, it is probable that this apparent elevation is not significantly different to the levels seen in the other conditions. There was no overall difference in mean (±SD) cortisol levels between the samples taken when the sensory integration therapy was in effect and when the behavioral intervention was in effect. For Participant 2, cortisol levels were also found to be slightly higher in baseline than in the alternating treatments phase. Mean cortisol levels reported during the alternating treatments phase indicated a slightly higher level in the SIT condition compared to the behavioral intervention condition. Once again, given the variation in standard deviations, such variations should be interpreted conservatively as indicating no significant difference. Results from the analysis for Participant 3 showed an apparently higher mean level of cortisol in the baseline condition compared to that found in the SIT condition or the behavioral intervention condition. On this occasion, the standard deviations warrant some comment. Firstly, the similarity of standard deviation between baseline and behavioral intervention levels suggests that the comparison between the two is likely to be valid, thereby suggesting a real difference between the two conditions. Secondly, the comparatively high standard deviation seen in the SIT condition, by contrast, suggests a greater degree of variability in cortisol during sensory integration therapy than during baseline or behavioral intervention. No salivary cortisol samples were taken for Participant 4.

Table 2 Overall mean levels (±SD) of salivary cortisol (μg/dl) for Participants 1, 2, and 3 across the alternating treatments phase of the study

Participant	Baseline	SIT	Behavioral intervention
1	0.10 ± 0.05	0.08 ± 0.01	0.08 ± 0.02
2	0.12 ± 0.06	0.10 ± 0.04	0.09 ± 0.02
3	0.12 ± 0.01	0.10 ± 0.07	0.08 ± 0.02
4	–	–	–

It can be noted that the salivary cortisol measures observed in the present study are relatively low when compared with normative resting data for children in the general population. Up to the age of 11, mean cortisol levels in children appear to range from 0.12 to 0.30 μg/dl across the day (McCarthy et al. 2009). The levels observed in the present study are more typical of levels ordinarily seen at one standard deviations below the mean for baseline measures taken at home on a typical day (0.06–0.15 μg/dl), which, if indicative of persistent reactivity to ambient stress, would approximate the 84th percentile of the population.

An analysis of the daily mean scores from analyses of salivary cortisol samples taken across the alternating treatments phase of the study. For each of the participants, there is little variability across mean daily salivary cortisol levels during the alternating treatments phase. For Participant 1, the highest level of cortisol (0.09 μg/dl) was reported during both the SIT condition and the behavioral intervention

condition. Lowest levels of salivary cortisol from the samples analysed for this participant were taken on day 7, when the behavioral intervention was in effect. Analysis of salivary cortisol samples obtained from Participant 2 showed that the highest level of cortisol (0.13 μg/dl) was obtained during baseline and SIT conditions. Lowest levels of cortisol for this participant were recorded on day 5 (0.07 μg/dl), when the behavioral intervention was in effect. For Participant 3, the highest levels of salivary cortisol (0.19 μg/dl) were obtained on day 7, during the SIT condition. Lowest levels of cortisol obtained from the analysis for this participant was 0.07 μg/dl and this was recorded during both SIT and the behavioral intervention conditions.

Discussion

Results of the functional assessments conducted in Phase 1 of the study led to the identification of the variables maintaining target behaviors for each participant. Recommendations for the sensory integration treatment were sought from an Occupational Therapist, trained in the use of sensory integration theory and techniques. For each participant, a sensory-integration therapy and a behavioral intervention were compared within an alternating treatments design. Results from this phase of the study demonstrated that the behavioral intervention was more effective in reducing levels of challenging behavior than the sensory integration therapy for all four participants. Furthermore, for each of the participants, relatively little change was observed in the rate of challenging behavior between the baseline condition and the SIT condition. For example, results for Participant 1 showed that the average daily rate of challenging behavior increased during the SIT condition when compared to baseline. Results for Participant 3 showed no difference between baseline rates of the target behaviors and the SIT condition. Analysis of salivary cortisol samples revealed relatively low levels of cortisol across the participants, and very little difference between levels of stress during the SIT condition and the behavioral intervention condition. Insofar as data from such a small sample can be compared with the results of previous studies, it can be noted that psychological stress has in the past been associated with increased cortisol production (Jansen et al. 2003). In the present study, it can be noted that the behavioural intervention conditions were associated with superficially lower levels of cortisol than baseline conditions for all three participants, with standard deviations implying that this distinction might be considered clear in respect of Participant 3. Cortisol during the behavioural intervention also appeared lower than during the SIT conditions although, given within-group variability, this cannot be considered statistically reliable.

This study further demonstrates the utility of assessment procedures that identify the functional properties of behavior disorders. The data generated from the assessment successfully identified maintaining variables and were also imperative in designing an effective intervention that would effectively reduce challenging behavior for each participant. Results showed that the behavioral intervention successfully reduced challenging behavior to zero levels for Participant 2 and near zero levels for Participant 1, 3 and 4 on conclusion of the study.

The findings of this study demonstrate the effectiveness of a behavioral intervention over a sensory based intervention in treating challenging behavior. These results are consistent with previous findings on sensory-integration therapy in reducing rates of challenging behaviour emitted by individuals with autism diagnoses (Devlin et al. 2009; Mason and Iwata 1990). Devlin et al. (2009) demonstrated that a behavioral intervention was more effective in reducing SIB than a sensory-integration intervention and when the behavioral intervention was consistently applied in the best treatment phase, further reduction was observed in the frequency SIB. Mason and Iwata (1990) demonstrated that rates of SIB did not result in a reduction during sensory-integration therapy while rates of SIB reduced to zero levels during a behavioral intervention phase. Together these studies demonstrate the importance of providing function-based treatment for challenging behavior. In each of these studies the behavioral intervention was designed based on a functional analysis or a thorough functional assessment of the problem behavior presented. The behavioral intervention was successful in reducing and eliminating the target behavior. However, during sensory-integration therapy, techniques were applied without an analysis of the function of the behavior under investigation. As a result the behavior may have been reinforced through positive social reinforcement.

Because SIT views problem behavior as a lack of organization of the senses that results in the inability to process complex sensory information in an effective manner, it often involves contingent application of sensory input following disruptive behavior. This presents as a valid explanation for the increase in challenging behavior for Participant 1. In this case, contingent on the occurrence of challenging behavior, the participant accessed sensory input, which also, inadvertently, provided social positive reinforcement, ranging from continuous physical contact to multiple forms of physical and social interaction which may have led to the increases observed in rates of challenging behavior.

It could be argued that the nature of the design used in the current study, where the treatments were randomly alternated across daily sessions, presented limitations to the potential therapeutic value of the sensory integration

treatment. However, it is unlikely that extended application of sensory integration would have produced different results. In any case, the lack of consistency across an extended number of daily sessions would also have adversely affected the efficacy and potential success of the behavioral interventions. This is demonstrated in the best treatment phase where further reductions were observed in rates of challenging behavior for each participant when the behavioral interventions were consistently applied in the final phase.

SIT remains a popular treatment among various consumers despite lack of evidence for its efficacy (Arendt et al. 1998; Watling et al. 1999). SIT is a resource intensive intervention that is often incorporated with other treatments for autism resulting in an 'eclectic' approach. Because of the nature of sensory integration therapy, it is often proposed as a necessary treatment option for stereotypy or behaviors maintained by automatic reinforcement. In the current study, the functional assessments did not identify an automatic function for the behaviors displayed by any of the participants. Future research should examine the efficacy of SIT for behaviors that potentially have a sensory function as opposed to those maintained by environmental events.

It can be noted that the salivary cortisol measures observed in the present study are relatively low when compared with normative resting data for children in the general population. Up to the age of 11, mean cortisol levels in children appear to range from 0.12 to 0.30 μg/dl across the day (McCarthy et al. 2009). The levels observed in the present study are more typical of levels ordinarily seen at one standard deviations below the mean for baseline measures taken at home on a typical day (0.06–0.15 μg/dl), which, if indicative of persistent reactivity to ambient stress, would approximate the 84th percentile of the population. These relatively low and stable levels of salivary cortisol across the participants warrant particular consideration. Salivary cortisol has been demonstrated to be a reliable indicator of psychological stress in child populations (Gunnar and Vazquez 2006). However, not only did the present participants exhibit cortisol at the 84th percentile for the age-matched population, they also exhibited no changes in cortisol across time despite the fact that marked reductions in challenging behavior were observed. This could be interpreted as implying that fluctuations in challenging behavior were not accompanied by alterations in subjective perceptions of stress, or that neither SIT nor behavioral intervention moderated perceived stress. Crucially, previous research has suggested that the manner in which stress is subjectively perceived is an important determinant of stress-related cortisol responding. Specifically, a number of studies have suggested that psychological stressors are more likely to elicit stress-related cortisol elevations in older children if they threaten the child's sense of social self (Gunnar et al. in press). The fact that cortisol levels were both low and stable in the present sample may reflect an inability of participants to perceive stress in terms of its social significance, consistent with their diagnoses of Autism Spectrum Disorder. Future research using cortisol as an indicator of stress may benefit from an analysis across an extended period of time with only one intervention in place. This would require a matched dyad/group design with each group receiving different interventions.

Given the implications discussed above, it is crucial that more comparative studies are conducted within this area. Additional participants are required to strengthen the findings of the current study. In addition, the intrinsic effects that SIT may have on environmental variables by nature of its mode of application (e.g., increased attention and reduced demands), warrant investigation within the treatment of developmental disabilities.

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