SPECIAL ISSUE PAPER

Pilot Study: Efficacy of Sensory Integration Therapy for Japanese Children with High-Functioning Autism Spectrum Disorder

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Abstract

This study's objective was to investigate the efficacy of sensory integration therapy (SIT) for children with high-functioning autism spectrum disorder (HFASD). The subjects were 20 HFASD children with IQs above 70 selected from previously collected data. Eight participated in individual SIT sessions, and 12 participated in group therapy (GT) including social skill training, communication training, kinetic activities, and child–parent play for 8–10 months. Changes in Total score and five Index scores on the Japanese version of the Miller Assessment for Preschoolers before and after therapy between children in the SIT and GT groups were compared. The results showed that Total score and all Index scores except for Verbal Index increased significantly in the SIT group, while only Total score increased in the GT group. Furthermore, the SIT group showed more improvement compared with the GT group in Total score and on Coordination, Non-verbal, and Complex Index scores. SIT might have a more positive effect on motor coordination abilities, non-verbal cognitive abilities, and combined abilities of sensory motor and cognition in children with HFASD when compared with GT. This study has limitations such as being an analysis of previously collected data. Further study should be conducted with a randomized control trial.

Received 10 October 2012; Revised 21 June 2013; Accepted 26 June 2013

Keywords

autism spectrum disorder; sensory integrative therapy; paediatric occupational therapy

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Published online 25 July 2013 in Wiley Online Library (wileyonlinelibrary.com) DOI: 10.1002/oti.1357

Introduction

Sensory integration (SI) theory was originally developed by A. Jean Ayres to focus on the neurological processing of sensory information (Ayres, 1972). Sensory integrative therapy (SIT) or SI approach has been used for the treatment of challenged children since the 1970s. Many studies have demonstrated the effectiveness of the SIT approach for challenged children (Grimwood and Rutherford, 1980; Ottenbacker, 1982; Ziviani et al., 1982; Polatajko et al., 1991; Allen and Donald, 1995; Case-smith and Bryan, 1999; Linderman and Stewart, 1999; Candler, 2003; Miller et al., 2007a, 2007b; May-Benson and Koomar, 2010).

Sensory integrative therapy has also been applied to children with autism spectrum disorders (ASD). An Internet survey questioning treatments used for children with ASD revealed that SI was the third most commonly reported intervention (Green et al., 2006). Some researchers have investigated the efficacy of SI treatment for children with ASD. For example, Miller et al. (2007a) indicated that children with ASD undergoing occupational therapy using the SI approach (OT-SI) made significant gains compared with an Activity Protocol group and a no treatment group on goal attainment scaling, the Attention subset, and the Cognitive/Social composite of the Leiter International Performance Scale—Revised. The OT-SI group improvement trends on the Short Sensory Profile, Child Behavior Checklist, and electrodermal reactivity were in the hypothesized direction. Additionally, Fazlioğlu and Baran (2008) reported that statistically significant differences in the Sensory Evaluation Form for Children with Autism scores between SIT groups and control groups indicated that SIT programmes positively affected children with autism. Pfeiffer et al. (2011) identified significant positive changes in children with ASD in a SIT group when compared with a fine motor treatment group and a significant decrease in autistic mannerisms in the SIT group. Additional studies of children with ASD or pervasive developmental disorder have provided preliminary support for SIT in areas such as reducing self-stimulating behaviours and increasing functional behaviours such as social interaction and play (Case-Smith and Bryan, 1999; Linderman and Stewart, 1999; Smith et al., 2005; Watling and Dietz, 2007). However, some studies have not affirmed the effectiveness of SIT compared with other therapy forms. A review study (Baranek, 2002) suggested that outcomes of SIT for children with autism in psychoeducational and motor categories are stronger than in other areas, at least for SI studies compared with no treatment conditions; however, effects appeared to be equal when compared with alternative treatments. Devlin et al. (2011) reported that behavioural intervention was more effective than SIT in the treatment of challenging behaviour of children with ASD. Section On Complementary And Integrative Medicine; Council on Children with Disabilities; American Academy of Pediatrics cautioned that parents should be informed that the amount of research regarding the effectiveness of SIT is limited and inconclusive (Section On Complementary And Integrative Medicine; Council on Children with Disabilities; American Academy of Pediatrics et al., 2012). Thus, although SIT has been adopted for children with ASD, its effectiveness is controversial.

Many studies demonstrated that improvements in sensory-motor skills, motor planning, and reading-related skills in children with learning disabilities, with mental retardation, or with developmental coordination disorder (DCD) were seen using SIT or SI treatment (Grimwood and Rutherford, 1980; Humphries et al., 1990; Wilson and Kaplan, 1994; Allen and Donald, 1995; Leemrijse et al., 2000; Wuang et al., 2009). However, there were no studies investigating the effectiveness of SIT for cognition, motor performance, or motor planning in children with ASD except for a single case report (Schaaf et al., 2012). Hence, an examination of the effectiveness of SIT for not only behaviour but also cognition, verbal, motor, or praxis abilities in children with ASD is warranted.

In order to clarify the effectiveness of SIT on cognition, verbal, motor, and praxis abilities on children with ASD, a comprehensive test tool is needed. The Japanese version of the Miller Assessment for Preschoolers (JMAP) (Tsuchida et al., 1989) is a standardized test that assesses cognitive abilities, verbal abilities, and sensory-motor abilities. Therefore, we expect the JMAP would be able to detect changes in the cognitive, verbal, and sensory-motor abilities in children before and after therapy. To examine the effectiveness of SIT, we compared score changes on the JMAP for individual SIT to common group therapy (GT) treatment methods by analyzing previously collected data from children with HFASD.

Thus, the purpose of this study was to examine the effectiveness of SIT on cognition, verbal, and sensory-motor abilities in children with ASD.

Method

Subjects

Subjects who satisfied the following conditions were selected from Nagasaki Prefectural Medical Treatment and Education Center's clinical records and a clinic of Nagasaki University clinical records by the first author while serving there from 1995–2011 (Table I).

(1) The subject was diagnosed with autistic disorder, Asperger's disorder, or pervasive developmental disorder not otherwise specified by paediatricians according to DSM-IV (APA, 1994).
(2) The subject had an IQ above 70 using the Tanaka–Binet test.

Table I. Descriptive statistics for participants and period of therapy

	Group		
	Individual sensory integration	Group therapy	*p*
Number	8	12	
Male : female	8:0	10:2	ns
IQ	100.7 ± 9.6	94.8 ± 9.1	ns
Autism : Asperger	3:5	6:6	ns
Age in months at start of therapy	56.8 ± 9.0	56.3 ± 6.8	ns
Therapy duration (months)	9.3 ± 1.0	9.3 ± 0.9	ns

(3) The subjects had participated in individual SIT or GT for durations of between 8 to 10 months.

(4) The subject took the JMAP examination and completed data both before therapy and after therapy.

(5) Age at first and second testing was within the target age of JMAP, which was between 2 years and 9 months, and 6 years and 2 months.

(6) Parents gave informed consent to use data for this study during the first visit.

The basic programme at Nagasaki Prefectural Medical Treatment and Education Center was GT. However, some children could not participate in these groups because the groups were full. The first author conducted SIT in this institution to the children who could not enter GT. Some children were chosen from the clinic at Nagasaki University. These children were given SIT by the first author in a SIT room at Nagasaki University. Most of the subjects in both institutions were introduced by public health nurses or kindergarten teachers in order to provide possible therapies and to get advice for children's behaviour or communication problems. Therefore, the parents of this study's subjects did not choose institution and therapy style.

Therapy for children with autism spectrum disorder

Subjects were given either SIT (1 h) or GT (1.5 h) weekly. SIT was conducted by the first author individually. The first author is a SI therapist certified by the Japanese Sensory Integration Association. During SIT, the first author, also an occupational therapist, and a child interacted in a therapy room equipped with sensory and kinetic equipment such as a swing, ball pit, balance beam, ladder, and trampoline. The child interacted with the sensory and kinetic materials in an active, meaningful, and fun manner. Recently, the Ayres Sensory Integration Fidelity Measure (ASIFM) (Parham et al., 2011) was proposed with the following parameters: 1) Ensures physical safety; 2) Presents sensory opportunities; 3) Helps the child to attain and maintain appropriate levels of alertness; 4) Challenges postural, ocular, oral, or bilateral motor control; 5) Challenges praxis and organization of behaviour; 6) Collaborates in activity choice; 7) Tailors activity to present just-right challenges; 8) Ensures that activities are successful; 9) Supports a child's intrinsic motivation to play, and 10) Establishes a therapeutic alliance. However, the SIT used in this study was not formally examined by the ASIFM because it had not yet been established. Instead, the first author incorporated the principles of SI (Ayres, 1979; Koomar and Bundy, 1991). For example, the therapist established a safe environment both physically and emotionally, provided praise, feedback, and instruction, made challenges on postural, ocular, and bilateral motor controls, and made appropriative challenges on praxis and organization. The activities were individually planned to present just-right challenges and to tap the client's inner drive, chosen with regard to be client's interest and opinion, consistently modified to succeed and to engage, and designed to offer opportunities for enhanced sensory intake of tactile, vestibular, and proprioceptive information.

The GT programme included social skill training, communication training, kinetic activities, and child–parent play. In this therapy, an occupational therapist, a speech therapist, and three nursery school teachers interacted with five to six challenged children. Because the contents of GT were not adapted to each child, GT only fulfilled parameters "1. Ensures physical safety" and "2. Presents sensory opportunities" in ASIFM.

Instrument

Subjects were assessed using the JMAP (Tsuchida et al., 1989), a re-standardized version of the Miller Assessment for Preschoolers (MAP) for use with Japanese children. The JMAP is composed of the following five major developmental indices: 1) Foundation Index; 2) Coordination Index; 3) Verbal Index; 4) Non-verbal Index; and 5) Complex Index. Items in the Foundation Index evaluate the child's sense of spatial position and movement, sense of touch, and development of the basic components of movement. The Coordination Index includes items that

evaluate gross, fine, and oral motor abilities. The Verbal Index includes items that examine memory, sequencing, comprehension, association, and expression in a verbal context. The Non-verbal Index includes items that test memory, sequencing, visualization, and the performance of mental manipulations not requiring spoken language. The Complex Task Index includes items that measure the combined abilities of sensory motor and cognition (Miller, 1988). Total and Index scores are expressed using percentile scores.

Procedure

The first author, who has been trained to administer and interpret the JMAP, administered the JMAP to all of the subjects individually before and after therapy. Data were excluded for children who could not follow or comprehend the instructions for the JMAP, or whose score was noticeably affected by his inattention, impulsiveness, hyperactivity, or inability to understand the instructions.

Data analysis

The Kolmogorov–Smirnov test indicated that JMAP's Total score and several Index scores for both groups at first examination were not normally distributed. Therefore, we used nonparametric statistics. First, before and after therapy, JMAP data were compared for each group using the Wilcoxon signed-rank test. Next, changes in Total score and each Index score before and after therapy were compared between the SIT group and GT group using Mann–Whitney test.

Results

Subject selection

The Japanese version of the Miller Assessment for Preschoolers data were available from a total of 243 children. Of these children, 84 did not have autistic disorder or Asperger's disorder and were excluded from the present analyses. Of the remaining 159, 29 were excluded for having IQ scores less than 70. From the 130 children left, 78 were excluded for having been tested only once. From the remaining 52, 28 were excluded for having a test–retest period shorter than 8 months or longer than 10 months. Thus, data from the remaining 24 children fulfilled the conditions outlined in the Method section. However, test reports described that several item scores in four cases were lacking in reliability because these subjects had problems in attention or hyperactivity. Therefore, these children were excluded, and the data from the remaining 20 subjects were analyzed in this study. In these subjects, 8 children received individual SIT and 12 children received GT. Seventeen of the subjects who met the inclusion criteria were treated in Nagasaki Prefectural Medical Treatment and Education Center. Twelve children of them received GT and five received SIT. Three children who received SIT were treated in the clinic at Nagasaki University. All individuals who worked with the children (e.g., public health nurses or kindergarten teachers) and all parents had no knowledge of SIT before the first visit. All of the subjects belonged to regular kindergartens or nursery schools, and none of the subjects were medicated. Additionally, no subject had previously received any other type of therapy.

Japanese version of the Miller Assessment for Preschoolers Index score changes before and after therapy within each group

Figure 1 presents mean scores and standard deviations for the SIT group before and after therapy on Total and Index scores on the JMAP. There were significant gains from before to after therapy for Total score (mean gain ± SD = 34.38 ± 21.98) ($W = 36$, $p = 0.012$), Foundation Index score (mean gain ± SD = 34.13 ± 34.21) ($W = 26.5$, $p = 0.035$), Coordination Index score (mean gain ± SD = 46.75 ± 36.26) ($W = 361$, $p = 0.012$), Non-verbal Index score (mean gain ± SD = 45 ± 24.26) ($W = 28$, $p = 0.018$), and Complex Index score (mean gain ± SD = 30.75 ± 20.73) ($W = 28$, $p = 0.018$). However, Verbal Index score showcased no significant changes (mean gain ± SD = 13 ± 44.26) ($W = 24$, $p = 0.401$).

Figure 2 shows mean scores and standard deviations for the GT group before and after therapy on Total and Index scores. While Total score showed a significant gain from before to after therapy (mean gain ± SD = 8.25 ± 11.69) ($W = 43$, $p = 0.015$), Foundation Index score (mean gain ± SD = 11.33 ± 25.54) ($W = 13$, $p = 0.138$), Coordination Index score (mean gain ± SD = 8.92 ± 17.87) ($W = 30.5$, $p = 0.08$), Verbal Index score (mean gain ± SD = 14.67 ± 31.2) ($W = 45$, $p = 0.075$), Non-verbal Index score (mean gain ± SD = 8.25 ± 36.6) ($W = 49$, $p = 0.433$),

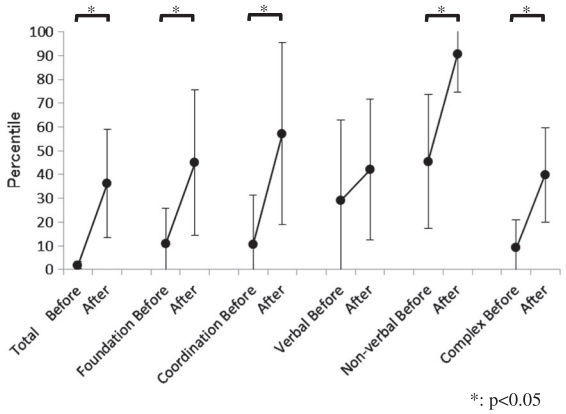

Figure 1 Mean scores and standard deviations for the sensory integration therapy group before and after therapy on Total and Index scores on the Japanese version of the Miller Assessment for Preschoolers

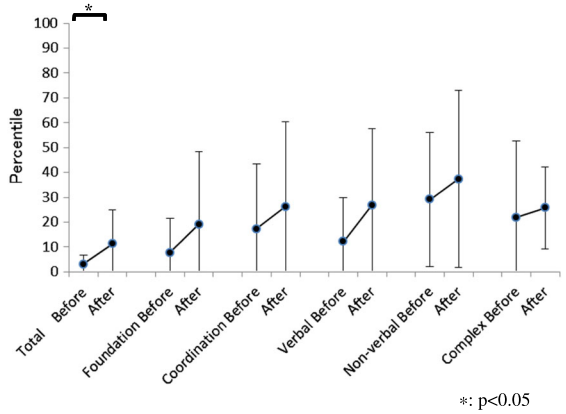

Figure 2 Mean scores and standard deviations for the group therapy group before and after therapy on Total and Index scores on the Japanese version of the Miller Assessment for Preschoolers

and Complex Index score (mean gain ± SD = 3.83 ± 31.2) ($W = 40.5$, $p = 0.505$) showed no significant changes.

Differences in score changes for Total score and each Index score before and after therapy between groups

By using the Mann–Whitney test, significant differences in score changes from before and after therapy between the two groups were found for the Total score ($U = 84$, $p = 0.005$), Coordination Index score ($U = 82$, $p = 0.008$), Non-verbal Index score ($U = 79$, $p = 0.016$), and Complex Index score ($U = 75.5$, $p = 0.034$) with the greater differences occurring in the SIT group compared with the GT group. There were no differences between the two groups for Foundation Index score ($U = 69.5$, $p = 0.086$) or Verbal Index score ($U = 48.5$, $p = 0.969$).

Discussion

The purpose of the present study was to clarify the effectiveness of SIT for children with HFASD. Although the present study did not employ a planned controlled trial, the efficacy of SIT and GT for HFASD was compared by examining differences in JMAP data changes before and after therapy in children with HFASD who had either received SIT or GT by analyzing previously collected data from children with HFASD retrospectively.

In the GT group, Total score was significantly improved from before to after GT; however, there were no significant changes in Index scores. Changes in item scores could not inflate Index scores to a significant level, whereas Total score might change significantly because all item score changes were combined in the Total score. Although the possibility that maturation

or other factors that may produce changes in JMAP scores cannot be ruled out, GT might have little positive affect on abilities that were examined by JMAP. In the SIT group, Total score and all Index scores except for Verbal Index score significantly increased after SIT. The results in score changes from before to after therapy indicated that SIT might improve fundamental sensory-motor abilities, coordination abilities, non-verbal cognitive abilities, and visual-motor abilities.

Comparison of score changes between the SIT group and the GT group using Mann–Whitney analysis showed differences in changes in Total score and three Index scores between the two groups. Because the change in the Coordination Index score was greater in the SIT group than the GT group, the efficacy of SIT for motor coordination abilities in children with HFASD was suggested. The present findings of improved motor coordination with SIT agree with the results of previous studies conducted on children with learning disabilities and mild mental retardation (Humphries et al., 1990; Wilson and Kaplan, 1994; Wuang et al., 2009). The Complex Task Index score was also improved in the SIT group compared with the GT group. Therefore, SIT was suggested to be effective on a combination of motor and cognitive abilities in children with HFASD. The SIT in the present study incorporated principles of SI (Ayres, 1979; Koomar and Bundy, 1991), included activities that were individually planned to present "just-right" challenges, was consistently modified for success and engagement, and made appropriative challenges on praxis and postural, ocular, oral, or bilateral motor control. These elements of SIT might contribute to improved motor abilities and combined abilities in motor and cognition in children with HFASD. Although motor coordination problems are not described in either the diagnostic criteria of Pervasive Developmental Disorder in the DSM-IV (APA, 1994) or ASD in the DSM-5 (APA, 2013), most children with ASD have motor problems. Green et al. (2009) reported that 79% of children with ASD had obvious motor dysfunction. Moreover, Mostofsky et al. (2006) suggested that children with ASD had problems in praxis. Several studies indicated that motor problems affect daily activities. For example, poor motor skills are a strong risk factor for becoming bullied (Bejerot et al., 2011). Children with probable DCD had an increased risk of mental health difficulties in later years (Lingam et al., 2012). Motor impairment in children with DCD was independently associated with lower participation diversity (Fong et al., 2011). Because SIT was demonstrated to be effective in motor coordination and for the combination of motor and cognitive abilities, it might provide a positive impact on abilities related to daily life functions. Changes in Non-verbal Index score from before to after therapy were greater in the SIT group compared with the GT group. Additionally, changes in the Complex Index score that reflect visual-motor function were greater in SIT than GT. Therefore, the effectiveness of SIT for visual cognitive abilities in preschool children with HFASD was suggested.

While three indices significantly changed, the Verbal Index did not showcase any significant differences in the scores from before to after SIT. In addition, there were no differences in the scores between the SIT and GT groups. Therefore, these results suggested that SIT did not improve verbal abilities in children with HFASD. Therefore, the results from the present study might indicate that skills closest to sensory-motor activities related to SIT are more likely to show changes than verbal skills that are further from these training elements.

Although previous work has criticized the efficacy of SIT compared with alternative treatments (Devlin et al., 2011; Section On Complementary And Integrative Medicine; Council on Children with Disabilities; American Academy of Pediatrics et al., 2012), the authors did not examine motor or praxis abilities. To date, there has been no studies examining the efficacy of SIT on motor, praxis, or cognitive abilities of ASD compared with no treatment or alternative treatment using standardized tests. Although the present study could not provide counterevidence for previous critical studies, it demonstrated the efficacy of SIT for motor, visual cognition, and visual-motor abilities, which had not been previously investigated in children with ASD.

The findings of the present study should be interpreted with a few limitations in mind. First, the present study did not compare changes in the score for SIT with other specific therapies. Additionally, the sample size was small, and the present study did not employ a randomized control trial. The number of children in each group was different, because the present study included a retrospective analysis of previously collected data. Both types of therapy were different in their therapy members. Each session length was different (1 h in SIT and 1.5 h in GT). Although treatments were different, there was overlap in that GT training included kinetic activities that were similar

to activities provided in SIT. The same therapist conducted SIT, but multiple staff members took part in GT, because the data were accumulated over a 16-year span. Parents' characteristics such as socioeconomic status were also unavailable. Furthermore, the first author did both testing and SI treatment. This may have biased the findings. Further study should be conducted with a randomized control trial to clarify the differences in the effectiveness of SIT and other forms of therapy for children with ASD.

Conclusion

The present study indicated that SIT was more effective for motor coordination abilities, non-verbal cognitive abilities, and the combined abilities of sensory motor and cognition in children with HFASD when compared with GT. Thus, occupational therapists could use SIT as one technique for the treatment of motor, visual cognition, and visual-motor abilities in preschool children with HFASD.

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