Effectiveness of Sensory Integration Interventions in Children With Autism Spectrum Disorders: A Pilot Study

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KEY WORDS
- autistic disorder
- child development disorders, pervasive
- outcome assessment (health care)
- psychomotor performance
- research design
- sensation disorders

The purpose of this pilot study was to establish a model for randomized controlled trial research, identify appropriate outcome measures, and address the effectiveness of sensory integration (SI) interventions in children with autism spectrum disorders (ASD). Children ages 6–12 with ASD were randomly assigned to a fine motor or SI treatment group. Pretests and posttests measured social responsiveness, sensory processing, functional motor skills, and social–emotional factors. Results identified significant positive changes in Goal Attainment Scaling scores for both groups; more significant changes occurred in the SI group, and a significant decrease in autistic mannerisms occurred in the SI group. No other results were significant. The study discusses considerations for designing future outcome studies for children with ASD.

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Autism spectrum disorders (ASDs) represent an expansive class of conditions that manifest in a range of deficits. Within this category of disorders, autism is the most predominant (Linderman & Stewart, 1999). The Centers for Disease Control and Prevention (2010) estimated the prevalence of ASDs at approximately 1 in 110 children. The number and type of symptoms can differ drastically and range from mild to severe. Symptoms fall into a range of categories, including problems with social interaction, perseveration (i.e., repetitive stereotypical movements), somatosensory disturbance (i.e., frequently engaging in movement or rocking), atypical developmental patterns, mood disturbances (e. g., overreactivity, lack of responsiveness), and problems with attention and safety (Mayes & Calhoun, 1999). Dysfunction in perceptual and sensory processing as well as in communication and neurological functioning results in various functional behavior limitations (Watling, Deitz, Kanny, & McLaughlin, 1999).

Sensory processing disorder (SPD) is quite common among children with ASD; reports in the literature range from 42% to 88% (Baranek, 2002). Children with evidence of sensory processing dysfunction, such as those with ASD, often have difficulty regulating responses to sensations and specific stimuli and may use self-stimulation to compensate for limited sensory input or to avoid overstimulation (Roberts, King-Thomas, & Boccia, 2007; Schaaf & Nightlinger, 2007; Smith, Press, Koenig, & Kinnealey, 2005). These atypical sensory reactions suggest poor sensory integration in the central nervous system and could explain impairments in attention and arousal (Baranek, 2002; Tomchek & Dunn, 2007). *Self-stimulatory behaviors,* defined as repetitive movements that serve no perceptible purpose in the environment (Smith et al.,

2005), can have considerable social, personal, and educational implications and often limit the ability to participate in normal life routines (Smith et al., 2005). Behaviors such as stereotypic motor movements, aimless running, aggression, and self-injurious behaviors have been correlated with these sensory processing abnormalities (Case-Smith & Bryan, 1999; Dawson & Watling, 2000; Linderman & Stewart, 1999; Watling & Dietz, 2007). Each behavior interferes with a child's ability to engage in or learn from therapeutic activities.

Sensory integration (SI) theory was originally developed by A. Jean Ayres to focus on the neurological processing of sensory information (Ayres, 1991; Baranek, 2002; Watling & Dietz, 2007). SI theory is based on the understanding that interferences in neurological processing and integration of sensory information disrupt the construction of purposeful behaviors (Schaaf & Miller, 2005; Watling & Dietz, 2007). Treatment is designed to provide controlled sensory experiences so that an adaptive motor response is elicited (Baranek, 2002). Interventions based on the classic SI theory use planned, controlled sensory input in accordance with the needs of the child and are characterized by an emphasis on sensory stimulation and active participation of the client and involve client-directed activities. In each session, a trained therapist artfully engineers the characteristics of the environment to create the "just-right challenge" (Baranek, 2002; Case-Smith & Bryan, 1999; Shaaf & Nightlinger, 2007; Smith et al., 2005). The goals of treatment are to improve sensory modulation related to behavior and attention and to increase abilities for social interactions, academic skills, and independence through better SI. The activities provided are meant to help the nervous system modulate, organize, and integrate information from the environment, resulting in future adaptive responses (Baranek, 2002).

Because SI is an extensively used treatment approach for children with ASDs (Watling et al., 1999), it is essential to establish the effectiveness of interventions to implement evidence-based practice. The use of evidence-based practice when choosing and implementing interventions is not only an ethical requirement of the profession of occupational therapy but also required under the Individuals With Disabilities Education Improvement Act of 2004 (IDEA; Yell, Katsiyannis, Ryan, McDuffie, & Mattocks, 2008), one of the largest funding sources for pediatric occupational therapy services. Conclusions as to the effectiveness of Ayres' SI treatment of children with ASD are limited by the types of designs and the lack of fidelity measures ensuring validity of the interventions provided. Current research has received mixed interpretation, dividing professionals as to the value of SI treatment (Miller, Schoen, James, & Schaaf, 2007; Parham et al., 2007). Studies of children with ASD or pervasive developmental disorder (PDD) have provided preliminary support for the effects of SI therapy in areas such as reducing self-stimulating behaviors and increasing functional behaviors such as social interaction and play (Case-Smith & Bryan, 1999; Linderman & Stewart, 1999; Smith et al., 2005; Watling & Dietz, 2007).

The SI approach is commonly used with children with ASD. Several methodological challenges within the current literature lead to questioning of the effectiveness of SI treatment, however. One such limitation is the number of Type II errors found within the studies. Without adequate power to show significant differences, it has been inferred that SI treatment is ineffective, even though differences have been ascertained (Miller et al., 2007). Further limitations are seen with the heavy use of single-subject and case study designs (Baranek, 2002; Case-Smith & Bryan, 1999; Linderman & Stewart, 1999; Roberts et al., 2007; Smith et al., 2005; Watling & Dietz, 2007). Although these approaches are helpful to inform practice, larger group designs are necessary to determine the power of interventions and to implement best practice (Schaff & Nightlinger, 2007). One of the biggest limiting factors is the failure to link the changes in behavior to the changes in dysfunction (Baranek, 2002). This failure could be the result of outcome instruments that are unrelated to expected outcomes or are not sensitive to change (Parham et al., 2007). Particularly when working with children with ASD, standardized measures appear inappropriate because of noncompliance, unresponsiveness, and the wide variety of behavioral and developmental levels in children with ASD (Case-Smith & Bryan, 1999). These challenges are compounded when the intervention, such as an SI treatment approach, is an individualized, interactive process (Parham et al., 2007).

Available research is limited in its generalizability because of design flaws and weak or ineffective outcome measures that produced mixed results. Research with the ASD population regarding the effectiveness of SI treatment is difficult in general because of children's varying developmental levels and the interactive nature of the treatment. This difficulty is exacerbated because the variability in the symptoms translates to unpredictable responses to intervention (Kasari, 2002). The purpose of this pilot study was to implement a high-level design to establish a model for randomized controlled trial (RCT) research, identify appropriate outcome measures with this population, and address the question of effectiveness of SI interventions in children with ASD.

Method

Participants

Participants in the study were a convenience sample of children diagnosed with autism or PDD not otherwise specified (NOS) on the basis of the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed., text rev.; American Psychiatric Association, 2000) criteria. All participants were between ages 6 and 12 (mean [*M*] age = 8.8) and attended a summer therapeutic activities program. A total of 32 boys and 5 girls participated in the study, a ratio that is consistent with the prevalence data of ASDs (Fombonne, 2003). Additional information on the participants, including coexisting treatment and class placement, is provided in the Results section. For this study, only children diagnosed with autism or PDD–NOS were included. Diagnoses were confirmed by parents and caregivers on the basis of reports from qualified diagnosticians. A total of 21 children diagnosed with autism and 16 children diagnosed with PDD–NOS participated. Children diagnosed with Asperger syndrome or another PDD were excluded from the study to promote greater homogeneity in the sample. In addition, participants were included only if they were identified with a sensory processing disorder as determined through a *T* score of ≥60 on the Sensory Processing Measure (SPM; Parham & Ecker, 2007), which was completed by the participants' parents, and a comprehensive evaluation by a clinician who was expert in SI. All evaluators had advanced training in SI assessment.

Thirty-seven students completed the intervention phase of the study, 20 of whom received the SI interventions and 17 of whom received the fine motor (FM) interventions. Four children dropped out of the study and were not included in the 37. Two were removed from the program by their parents, and two were asked to leave the program because of aggressive behaviors before the beginning of the interventions.

Procedures

The participants were randomly assigned to two treatment groups: (1) SI or (2) FM. A statistician who was not associated with the implementation of the study completed the random assignment using version 16 of the Statistical Package for the Social Sciences (SPSS) software program (SPSS, Inc., Chicago). The group assignments were provided to a project coordinator who was the on-site coordinator for the interventions. The researchers and parents or caregivers who completed the pre- and posttesting were blinded to group assignment. The researchers completed comprehensive occupational therapy evaluations before the start of the intervention phase of the study to determine the presence of sensory processing disorder and to complete standardized pretest assessments, which included the Quick Neurological Screening Test, 2nd Edition (QNST–II; Mutti, Martin, Sterling, & Spalding, 1998) and clinical observations.

On the basis of this information, measurable goals were developed in collaboration with the parents and caregivers for each child for use in the Goal Attainment Scaling (GAS; Mailloux et al., 2007). The goals focused on the three areas of sensory processing/regulation, functional fine motor skills, and social–emotional skills.

The researchers completed the Vineland Adaptive Behavioral Scales, 2nd Edition (VABS–2; Sparrow, Cicchetti, & Balla, 2005) through an interview with the parent or caregiver during the initial evaluation. This measure was used as a covariant during data analysis to account for the different levels of adaptive behavior of the participants. Additional pretest measures included three questionnaires completed by the participant's parent or caregiver: (1) the SPM, (2) the Social Responsiveness Scale (SRS; Constantino & Gruber, 2005), and (3) the Adaptability Scale of the Carey Temperament Scales (Carey & McDevitt, 1995). The same person completed these measures at posttesting. During the posttest phase of the study, the researchers reviewed the GAS with parents or caregivers over the phone to determine progress toward the identified goals.

Interventions were provided in the context of the summer therapeutic activities program. Three areas with appropriate equipment were designated for SI interventions; FM interventions were provided in a separate room. Each interventionist received training before implementing the intervention. The trainings and interventions were based on fidelity measures, one for the SI interventions and one for the FM interventions, that were used to determine the validity of the interventions. All the participants received 18 treatment interventions of 45 min each over a 6-wk period, except for one child who received only 17 treatments. This participant was absent on the last day of the program when scheduled to receive the final treatment session.

The SI treatment interventions were based on a theory and interventions originally developed by Ayres (1991). *SI-based treatment* is defined as "a program of intervention involving meaningful therapeutic activities characterized by enhanced sensation, especially tactile, vestibular, and proprioceptive, active participation, and adaptive interaction" (Bundy, Lane, & Murray, 2002, p. 479). The participants are actively involved in the

treatment process, and the outcome is to develop *adaptive interactions,* which occur between the participant and the environment (including other people) in which the person meets the demands of the task. To ensure that the interventions were based on the SI treatment theory, at least one treatment session for each child was videotaped by the onsite project coordinator and analyzed by the researchers using an SI treatment fidelity measure developed for research by Parham et al. (2007). This analysis was completed after final data collection and analysis to maintain blinding to group assignment. The researchers went through formal training in the use of the fidelity measure with therapists involved in the original development of the tool. A score of 80 was identified as the cutoff score for fidelity to SI interventions. All the observed treatment interventions received a score of ≥80.

The treatment interventions were based on the individual needs of each child but included the 10 key therapeutic strategies identified in the fidelity tool (Parham et al., 2007) that a therapist would use when providing SI-based treatment to a child: (1) arranging the room to entice engagement, (2) ensuring physical safety, (3) presenting sensory opportunities, (4) attaining and maintaining optimal arousal levels, (5) tailoring activities to present the just-right challenge, (6) ensuring that activities are successful, (7) guiding the self-regulation of behavior, (8) creating a playful context, (9) collaborating in activity choice, and (10) fostering therapeutic alliances. The 10 areas are encompassed under three main areas that consist of (1) providing the child with environmental modifications and sensory opportunities during the treatment session, (2) fostering adaptive responses and providing the just-right challenge, and (3) promoting the therapist–child relationship.

The FM treatment group participated in individual sessions with an occupational therapy graduate student under the direct supervision of an experienced occupational therapist for the same amount of time that the SI treatment interventions were provided. A fidelity measure for the FM interventions was developed for this study. The FM intervention sessions focused on three main activity areas: (1) constructional, (2) drawing and writing, and (3) FM crafts. In addition, the interventions needed to have the following characteristics to meet the fidelity criteria: (1) appropriate supports provided for the child to successfully accomplish the tasks while challenging his or her FM and visual–motor skills; (2) interventions based on the therapeutic needs of the child in the areas of visual and FM skills; (3) interventions based on the child's interests to maintain attention and focus on the task; (4) seating and positioning of the child adapted to address his or her specific size and motor support needs; and (5) activities that do not provide full-body proprioceptive, vestibular, or tactile sensory input. Points between 15 and 30 were assigned to each of the six areas. A score of 75 was identified as the cutoff score for fidelity to FM interventions. All the observed treatment interventions received a score of ≥75. Raters were provided with training before completing the study fidelity rating forms.

Without the study, none of the participants would have received occupational therapy services within the program because of limited funding sources for the facility. Data collected during the pretest phase of the study identified that 4 of the participants were receiving occupational therapy outside of the program setting during the study. In addition, 1 participant was receiving physical therapy services and 7 were receiving speech therapy. The researchers obtained institutional review board approval through Temple University and through the organization that offers the summer therapeutic program before implementing the study. Informed assent was obtained by the participants through verbal or nonverbal communication, if possible. An informed consent form was completed by the parent or caregiver of the participant.

Measurement Tools

Sensory Processing Measure. The SPM is a 4-point Likert-type scale that assesses processing issues, praxis, and social participation in children ages 5–12. The Home Version was used for this study and completed by the participants' parents or caregivers. The development of the tool was based on SI theory, consistent with the main treatment intervention used in the study. The tool takes approximately 15–20 min to complete and has seven indexes in the areas of visual, auditory, tactile, proprioceptive, and vestibular sensory systems as well as praxis and social participation. A *T* score is provided for all the indexes as well as the total test score. Internal consistency and interrater reliability were determined in the development of the test and were in very high ranges—.95 and .98, respectively—for the total sample population. Both content and construct validity were established for the test. The Home Version of the Sensory Processing Measure correlated appropriately to another measure assessing a similar construct and to the Main Classroom Version. Criterion-related validity was established through comparison of scores of neurotypically developing children to those with autism. The Sensory Processing Measure was able to distinguish between these two groups on the basis of the scores.

Social Responsiveness Scale. The SRS is a 65-item rating scale for children ages 4–18. The SRS measures

a child's social impairments, including the components of social awareness, social information processing, capacity for social communication, social anxiety and avoidance, and autistic preoccupations and traits. The scale is completed by a guardian or parent over a period of 15–20 min. Norms were developed on the basis of a sample of more than 1,600 children. The SRS demonstrates strong internal consistency, test–retest reliability, and interrater reliability with reliability statistics at ≥.9, ≥.77, and ≥.75, respectively. In studies, the SRS was able to distinguish between children with PDD and other diagnostic conditions and demonstrated strong discriminant validity. Concurrent validity was established when comparing the SRS with the Autism Diagnostic Interview–Revised.

Quick Neurological Screening Test, 2nd Edition. The QNST–II (Mutti et al., 1998) assesses 15 areas of neurological integration and helps identify possible neurological interference with learning in children from kindergarten to 12th grade. Specifically, it assesses areas including praxis, dexterity, visual tracking, spatial orientation, tactile perception abilities, and motor skills. The total test raw score was used in data analysis for this study. Raw scores are translated into one of three criterion areas—severe discrepancy, moderate discrepancy, and normal range—for clinical interpretation, although these were not used in the study data analysis. This tool was originally developed for use with children with soft neurological signs such as learning disabilities. The QNST–II was able to distinguish between children with learning disabilities and those without in a study to determine discriminant validity (Mutti et al., 1998). Test–retest reliability was strong at .81, and interrater reliability was moderately strong at .71. Moderate to strong validity was established in construct (underlying constructs and theory being measured), content (the domains assessed), and criterion-related validity (compared with similar tools). The QNST–II also demonstrated predictive validity. The QNST–II could predict average or better than average scores in reading at the end of first grade (Mutti et al., 1998).

Goal Attainment Scaling. GAS is a goal-setting process used to determine intervention outcomes expressly relevant to individuals and their families. GAS is able to depict functional and meaningful outcomes that are often challenging to assess using standardized measures (Mailloux et al., 2007). In various studies, GAS has been determined to be an effective outcome measure (Mailloux et al., 2007; Miller et al., 2007).

For this study, the goals were developed in conjunction with the primary caregiver by the researchers/evaluators and individualized for the child. Goals were divided into three areas: (1) sensory processing and regulation, (2) functional motor skills, and (3) social–emotional skills. Each participant had at least one goal in each of the three areas. The goals were shared with the interventionists to guide treatment planning.

GAS has a rating scale from –2 to +2; 0 is the anticipated performance by the end of the study interventions (Kiresuk, Smith, & Cardillo, 1994). The negative numbers represent less-than-expected outcomes, and the positive numbers represent greater-than-expected outcomes. The scores are transposed into standard scores for analysis. For this study, both the parent and treating therapist provided input into what score the child attained in each goal at the end of the study in order to establish interrater reliability. Validity was established by having both the parent and evaluating therapists develop the goals together to ensure that the goals were relevant and at appropriate levels for the child.

Vineland Adaptive Behavior Scales, 2nd Edition. The VABS–2 is an individually administered measure of adaptive behaviors that assesses the domains of communication, daily living skills, socialization, and motor skills. It has a maladaptive behaviors section that assesses problem behaviors. Parents and caregivers were administered the survey interview form for the purpose of the study. The scores of the VABS–2 were not used to determine changes after interventions, but total scores were used as a covariant during data analysis to account for the diversity in the level of functioning and adaptive behaviors of the participants. More specific information obtained through the administration of the VABS–2 was used to guide the development of goals and treatment interventions. Internal consistency was established for the VABS–2 (Sparrow et al., 2005) and was found to be in the moderate to high ranges, ≥.75, for all domains. Test–retest reliability was established at .72 to .87 for the total test and interrater reliability at .81 to .83. With regard to validity, the test content, response process, test structure, and relationship to other measures all were within acceptable ranges. Eleven clinical groups, including people with autism, were defined in the development of the VABS–2 and used to determine validity.

Results

A statistical consultant to the study analyzed the data using SPSS. Table 1 presents *T*-test and χ^2 analysis of the demographic variables, which was completed to determine whether any differences existed between groups in the demographic information and baseline status.

Table 1. Demographic and Baseline Variables for Treatment (Sensory Integration) and Control (Fine Motor) Groups

Variable	Group		*p*
	Treatment (n = 20)	Control (n = 17)	
Age, mo; *M* (*SD*)	100.00 (24.78)	110.47 (24.78)	ns
Male, %	85.0	88.2	ns
Autism diagnosis, %	60.0	52.9	ns
PDD–NOS diagnosis, %	40.0	47.1	ns
Class placement, %			
Special education	80.0	70.5	ns
Regular education	20.0	29.5	ns
VABS–2, daily living, *M* (*SD*)			ns
Communication	62.90 (13.39)	64.24 (9.62)	ns
Socialization	63.90 (17.71)	64.24 (9.33)	ns
Motor	60.70 (13.20)	61.00 (11.24)	ns
Composite	66.80 (16.66)	70.18 (14.07)	
Parent baseline measures, *M* (*SD*)			
SPM total	68.50 (5.62)	67.88 (7.28)	ns
SRS total	82.95 (6.37)	82.71 (9.10)	ns
Child baseline measure, *M* (*SD*)			
QNST–II	61.91 (19.63)	33.91 (14.99)	<.001

Note. *M* = mean; *SD* = standard deviation; PDD–NOS = pervasive developmental disorder–not otherwise specified; VABS–2 = Vineland Adaptive Behavioral Scales, 2nd Edition; SPM = Sensory Processing Measure; SRS = Social Responsiveness Scale; QNST–II = Quick Neurological Screening Test, 2nd Edition; ns = not significant. QNST–II is based on n = 11 for both the sensory integration and the fine motor groups because the rest of the participants in each group were unable to follow directions to complete this measure.

A χ^2 analysis was also completed on the services children in each group were receiving outside of the experimental and control conditions; no significant differences were found between the two groups in occupational, physical, and speech therapy and the behavioral interventions that each group received. An analysis of covariance (ANCOVA) was completed to compare the pretest and posttest scores on the SPM, SRS, GAS, and QNST–II for the FM and SI treatment groups. An ANCOVA was completed with scores on the VABS–2 used as a covariant to account for differences in the adaptive behavioral levels of the participants. During the analysis, a partial η^2 was calculated to determine effect size.

Although both groups demonstrated significant improvements toward goals on the GAS, the SI group demonstrated more significant improvement than the FM group in the attainment of goals as rated by parents ($F[1, 34] = 4.87$, $p < .05$, effect size = 0.125) and teachers ($F[1, 30] = 16.92$, $p < .01$, effect size = 0.360). The goals focused on the three categories of sensory processing, motor skills, and social functioning. This finding indicates that the variables are relevant to an efficacy trial.

The SI group displayed significantly fewer autistic mannerisms than the FM group, as measured by a subscale of the SRS ($F[1, 33] = 4.97$, $p < .05$, effect size = 0.131), indicating that SI interventions may have an impact on core symptoms of ASD. No significant differences were found between the two groups on sensory processing standardized scores, other subscales of SRS, or the QNST–II. The QNST–II is the only test that required a standardized administration to all participants. With the great variability in ASD, a subgroup of participants in both groups (SI: $n = 9$; FM: $n = 6$) could not complete the standardized administration of the pretest QNST–2. A subsequent analysis was completed using the χ^2 test on frequencies for participants who were then able to complete or partially complete the posttest QNST–II in both the FM and SI treatment groups. A significantly larger group of participants in the SI group (70%) than in the FM group (17%) were able to complete part or all of the QNST–II from pretest to posttest (χ^2 [1, $N = 16$] = 4.56, $p = .03$). The SI group members who were able to complete the QNST–II showed a significant change from pretest to posttest, whereas the FM group did not (SI: pretest M = 61.91, posttest M = 39.36; FM: pretest M = 33.91, posttest M = 24.60). This finding should be interpreted with caution because the SI and FM groups were significantly different at baseline.

Discussion

The purpose of this pilot study was to provide preliminary information on the effectiveness of SI interventions for children with ASDs and to obtain pilot data to guide future studies in design, measurement, and methodology. The results of the study were mixed yet demonstrated significant changes in the autistic mannerisms (a component of social

responsiveness) and significant progress toward individualized goals in the areas of sensory processing and regulation, social–emotional function, and FM skills. No significant differences were found in the scores on the SPM or the QNST–II. A subsequent analysis did identify that significantly more children could complete or partially complete the QNST–II after intervention.

Results identified significant postintervention differences in social responsiveness between the SI and FM groups, as determined by SRS scores in the area of autistic mannerisms. Children in the SI group had significantly fewer autistic mannerisms after interventions. Previous studies found similar outcomes when assessing the reduction of stereotyped or self-stimulatory behaviors in children with PDD after sensory-based or SI interventions (Smith et al., 2005; Watling & Dietz, 2007). Autistic mannerisms "include stereotypical behaviors or highly restricted interests characteristic of autism" (Constantino & Gruber, 2005, p. 17). Watling and Dietz (2007) measured engagement behaviors that are influenced by "undesirable behaviors such as stereotypical motor movements" in a study with four children with ASDs (p. 574). The results identified an improvement in engagement behaviors after a latency period, although not immediately after treatment. Another study by Smith et al. (2005) compared the "effects of occupational therapy using an SI approach and a control intervention of tabletop activities" (p. 418). The self-stimulatory behaviors in the SI group significantly decreased. These studies focused primarily on using a single-subject design or had very small sample sizes compared with the RCT design used for this study.

People with autism have reported (Shoener, Kinnealey, & Koenig, 2008) that self-stimulatory behaviors often serve as a regulatory function, allowing them to process sensory information from the world around them and attend without the alternative, which is sensory overload. The reduction of autistic mannerisms or self-regulatory behaviors may be indicative of a better ability to process sensory stimuli in the environment without the need for regulatory strategies. Although essential for some people on the autistic spectrum, autistic mannerisms are often perceived as socially inappropriate by neurotypical people. This perception can contribute not only to barriers of communication but also to acceptance in mainstream society. In addition, the ability to self-regulate is essential for quality of life.

No significant differences in the FM and SI groups were found in the scores on the SPM or the QNST–2 or from pretest to posttest. Many reasons could exist for the nonsignificant results, ranging from a lack of generalizability of the interventions in other settings to measurement issues. With regard to the effectiveness of the interventions, the interventions may not fully reflect common clinical practice because recommendations for generalization into other environments were not provided. Occupational therapists provide interventions that are typically carried over into the life roles and daily routines of individual clients, a process that allows for generalizability of intervention effects in many environmental contexts. This study focused solely on interventions in a clinical setting with no home or classroom interventions or consultation because of the need to maintain blinded evaluators and interventions that maintained fidelity. Many of the measures were completed by the parents, who observed the child in the home setting rather than in the setting where the interventions were provided.

In addition, the sensitivity of the measurement tools may have influenced their ability to detect change. Among the most important findings of this study in guiding future research were the issues identified with measurement. The SPM and the QNST–II have not yet been established psychometrically to measure changes over time, which may be a factor in the outcome of the study. Further, the tools were not specifically developed for use with children with PDD. Although no significant changes were found on the overall scores of the SRS, significant changes were found in the area of Autistic Mannerisms on the SRS. The SRS was specifically developed for use with children with PDDs (Constantino & Gruber, 2005). Certainly, a limitation for this current study and an area for future studies are the issues with objective measurement tools for children on the autistic spectrum.

Measurement issues are a common problem when assessing children on the autistic spectrum. Standardized measures are often inappropriate because of the wide variety in behavioral and developmental levels (Case-Smith & Bryan, 1999) and the ability of a child with ASD to complete the test while maintaining test validity. These challenges are compounded when the intervention, such as SI treatment, is individualized to children's specific needs and results in a diverse range of goals and outcomes among participants within a given study. It is therefore important to find measurement tools that accurately reflect the individualized needs and great variability in this population.

The results of the study supported the use of more individualized measures, such as GAS, to determine progress and change in both research and clinical practice. Significant improvements occurred in GAS scores in both groups; the SI group demonstrated more improvement. The goals were developed with the parents and evaluating

therapists before the start of the intervention and then rated after the intervention. Specifically, three main goal areas focused on constructs influenced by SI interventions: (1) social–emotional function, (2) sensory processing, and (3) FM functional skills. Mailloux et al. (2007) found that "GAS is especially promising for occupational therapy because it captures the individuality of meaningful and relevant changes in occupational performance that have previously been difficult to measure" (p. 258). Moreover, Miller et al. (2007) determined that GAS showed the most pretest–posttest change for their pilot study. On this basis, it is possible that GAS could be used as an effective and sensitive measure for children with ASD and SI treatment.

GAS data were analyzed using standard scores that were based on all three goal areas. It is likely that the FM intervention group also demonstrated changes, because their interventions likely had a significant impact on the FM functional goals. These findings provide preliminary support for not only the use of SI interventions but also the FM interventions used in the study. When using GAS both clinically and in research, it is important to ensure reliability and validity (King, McDougall, Palisano, Gritzan, & Tucker, 1999), because they can be one of the limitations of this tool. Because many children with ASDs are not able to take standardized tests and there is great heterogeneity within this group of people, GAS provides an individualized method to measure change and progress, both clinically and in research.

A significant difference was found between children in the SI and FM groups in their ability to complete parts or all of the standardized QNST–2 in the posttesting. The children receiving the SI interventions were better able than those in the FM group to complete parts of a standardized test after the interventions. This finding could be interpreted in many ways (e.g., better attention and focus, better ability to understand verbal directions, improvements in individual subtests). This analysis was completed only for children who could not complete the test at the pretest session. Differences between the groups were found in pretesting, so results should be considered only in guiding future studies.

Recommendations for Future Studies and Limitations

One of the purposes of this pilot study was to provide information to guide the development of future RCTs measuring the effectiveness of SI interventions in children with ASDs. An important recommendation would be to ensure that participants are more homogeneous so that the effectiveness of the interventions can be detected and clinically applied. The use of a measure such as the Autism Diagnostic Observation Scale (Lord, Rutter, DiLavore, & Risi, 1999) to establish groups that are more homogeneous in nature is suggested. The groups in the current study varied greatly in their adaptive behavioral levels. Although accounted for through statistical analysis in this study, other heterogeneous variables may have affected the outcome of the study specific to the diverse nature of autism spectrum disorders. As mentioned previously, other considerations in designing future studies include carrying over interventions throughout daily routines, which is more characteristic of occupational therapy services, and using measurement tools that are more individualized because of the diverse nature of people with autism. The GAS allows researchers to measure individualized outcomes but must be used in a method to ensure the greatest amount of reliability and validity (King et al., 1999).

Another consideration for future studies is the duration and intensity of interventions. This study focused on intense interventions over a short period of time, three sessions per week for 6 wk. It is important to determine the most appropriate frequency and duration for interventions to guide intervention planning and funding recommendations. Although the use of fidelity measures helped ensure consistency and validity of interventions, it is highly recommended that intervention manuals, in conjunction with fidelity measures, be developed for future effectiveness studies. Finally, an RCT that includes a larger sample size and the establishment of interrater reliability of the fidelity measures is necessary.

Clinical Implications

One of the largest funding sources for occupational therapy services for children with ASDs is IDEA, which requires that services be based on peer-reviewed research (Yell et al., 2008). This study provides preliminary evidence of the effectiveness of SI interventions; more important, it provides information to guide the development of future high-level research studies. IDEA also requires that clear measures be identified and used to determine progress. Methods of measuring progress in children with ASD are often difficult because of diverse outcomes and various needs influencing the ability to complete standardized tests validly. The results of this study support the use of GAS to measure outcomes from interventions because of the ability to individualize the goals. GAS can be used to measure progress in clinical settings as and is a potential tool for research.

Conclusion

This study provides preliminary support for using SI interventions in children with ASD, although further research is necessary. Results identified significant progress toward individualized goals and a decrease in autistic mannerisms after SI interventions, although no significant changes were found on the other measures. Results suggest implementing interventions that are generalized to home and community settings, using tools that allow for individualized sensitive measurement in future studies, and completing future studies with a larger sample. ▲

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