Sensory Integrative-Based Occupational Therapy and Functional Outcomes in Young Children With Pervasive Developmental Disorders: A Single-Subject Study

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Objective. This single-subject study explored the effects of sensory integrative-based occupational therapy provided in an outpatient clinic on the functional behaviors of two young children with pervasive developmental disorder (PDD) at home.

Method. The participants were two 3-year-old boys with PDD. Before the study, the participants had not received a consistent program of sensory integrative-based occupational therapy. Before the baseline phase, three target behaviors were identified for each child, using an adapted version of Cook's revised Functional Behavior Assessment for Children with Sensory Integrative Dysfunction. These target behaviors were operationalized and used as repeated measures taken in the home during both the 2-week baseline and treatment phases. The treatment phase was 11 weeks for Participant 1 and 7 weeks for Participant 2.

Results. Both participants displayed significant improvements in the areas of social interaction, approach to new activities, response to holding or hugging, and response to movement. Decreases were noted in the frequency and duration of disruptive behaviors (e.g., high activity levels, aggressive behaviors), with an increase in functional behaviors, such as spontaneous speech, purposeful play, and attention to activities and conversation. Concurrent interventions that were not part of this study (e.g., initiation of speech therapy, preschool, vitamins) may have confounded these results.

Conclusions. These findings support the application of sensory integrative-based occupational therapy as a part of the services provided to some children with PDD. Further research is needed to replicate these findings and to isolate the effects of sensory integrative-based occupational therapy because both participants were receiving other interventions at the time of this study.


Pervasive developmental disorders (PDDs) represent a category of disorders that involve deficits in sensory functioning. This extensive deficit in sensory processing is manifested in a variety of bizarre and atypical behaviors (Ayres & Tickle, 1980). Because of the heterogeneity and severity of deficits in the population of persons with PDD, a wide variety of symptoms have been noted, including repetitive and self-stimulating behaviors (e.g., repetitive hand movements, body rocking, unusual object manipulation, focused interests) (Baranek, Foster, & Berkson, 1997). Of the diagnoses included under the category of PDD, autism is the most prevalent (Accardo, 1996), affecting .7 to 4.5 of every 10,000 births (Behrman, 1994).
Some studies support the use of planned and controlled sensory input for enhancing the development and sensory processing of children with autism (Jang, 1996; McClure & Holtz-Yotz, 1990; Zisserman, 1991). Case studies by McClure and Holtz-Yotz (1990) and Zisserman (1991) indicated that programs of controlled deep pressure and tactile input successfully reduced the disruptive behaviors displayed by two children with autism. Ayres and Tickle (1980) investigated sensory processing disturbances in 10 children with autism (ranging in age from 3.5-13 years) as a predictor of response to sensory integrative-based occupational therapy. They found that children who registered but did not effectively modulate, sensory input responded to therapy more than children who were hyposensitive and did not attend to sensory input.

In a more recent study, Jang (1996) found that providing sensory integrative-based occupational therapy before structured behavioral therapy to a 5-year-old child with autism appeared to decrease the incidence of self-stimulating behaviors (e.g., rocking, waving hands, repetitive vocal patterns). The therapy involved 3 weeks of child-directed sensory integrative-based occupational therapy, twice weekly, before the structured, adult-directed behavioral therapy. Occupational therapy intervention included carefully controlled sensory input through vestibular and somatosensory activities (e.g., swinging from suspended equipment, deep touch, pressure) (Ayres, 1979). The generalizability of Jang’s results was limited by both the single-subject design and the short intervention phase. Additional research is needed to determine the isolated effects of sensory integrative-based occupational therapy for a period of several months, as advocated by many pediatric therapists, particularly because sensory techniques are currently being used by many therapists in the treatment of children with PDD. Additionally, it is important to measure the outcomes of this intervention in the neutral context of the home, where treatment effects are most functional. The purpose of this study was to explore the effects of sensory integrative-based occupational therapy on the performance of two pre-school-age children with PDD of functional behaviors in the following areas: (a) social interaction, (b) functional communication during mealtime, (c) approach to new activities, (d) response to holding, and (e) response to movement.

Method

Research Design

This study used a single-subject design, which included a baseline (A) and a treatment (B) phase. This design was chosen for its correspondence to the treating facility’s established procedure of completing an evaluation approximately 2 weeks before introducing treatment, thus avoiding the ethical dilemma of withholding treatment. This design allowed for target behaviors to be clearly specified and for repeated measures to be taken of them throughout the baseline and treatment phases (Barlow & Hersen, 1984).

Participants

Potential participants were pre-school-age children with PDD who were referred to the occupational therapy department at Mary Bridge Children’s Health Center in Tacoma, Washington. The children referred to this study had participated in a multidisciplinary evaluation by the Health Center’s Neurodevelopmental Group. Children who had received, or were currently receiving, a program of consistently applied sensory integrative-based occupational therapy approaches or who demonstrated, during the initial evaluation, an inability to tolerate the therapy techniques or the repeated measurement design, were excluded from participation in this study. Signed permission was obtained from the parents of the two children who were selected as participants. Treatment of all participants was in compliance with the ethical standards for the treatment of human subjects of the American Psychological Association (1992).

Participant 1 was a 3-year, 9-month-old boy who showed symptoms indicative of relatively mild autism (e.g., persistent echolalia, difficulty transitioning between activities, moderate tactile hypersensitivity, decreased social skills [no initiation of interaction], limited reciprocal interactions). He had not previously received occupational therapy services.

Participant 2 was a 3-year, 3-month-old boy who had been diagnosed with autism. He displayed a severe language delay, extreme hypersensitivity to tactile stimuli, and hyposensitivity to vestibular stimuli characterized by excessive spinning, jumping, and swinging. At the time of the study, he was attending an early intervention program approximately 12 hours per week in which he received occupational therapy services but not specifically sensory integrative-based occupational therapy. He began receiving sensory integrative-based occupational therapy from the health center 2 months before the initiation of this study, but because of illness and holidays, his attendance at treatment sessions was sporadic. It was thought that his therapy program lacked consistent application and, therefore, he was included as a participant in this study.

Instrument

The initial evaluation conducted by the occupational therapist at the health center included direct observation of the participant and a parent interview. Functional behaviors directly related to sensory processing were identified from these data and then measured at the home throughout the baseline and treatment phases of the study. The revised Functional Behavior Assessment for Children with Sensory Integrative Dysfunction (Cook, 1991) was used to measure the duration, quality, and frequency of various behaviors targeted for study. This scale allows for the identification of
functional skills and for the documentation of progress as measured by the levels of the scale. A higher score is indicative of better performance on the measured behaviors. For the purposes of the repeated measures required in a single-subject design, this scale was expanded from 4 to 10 points to allow for more sensitive measurement and accurate statistical analysis. Behaviors most likely to change as a result of short-term intervention were selected for study. The functional outcomes and target behaviors identified were social interaction skills, approach to new activities, and response to holding and hugging for Participant 1 and social interaction skills, functional communication during mealtime, and response to movement for Participant 2. During observations in the home, parents were asked to set up the home situation so that the child's target behaviors could be observed without disturbing the home routine. For example, during each observation session, Participant 1's parents were asked to present him with a new activity (e.g., toy, game) while the rater observed his reaction.

Reliability

Two raters, the first and second authors, collected data to establish interrater reliability in a pilot study. A videotape (1 hr in length) of a child with autism who was not included in this study was observed in 10-min increments and scored on the expanded 10-point scales of three target behaviors on the Functional Behavior Assessment for Children with Sensory Integrative Dysfunction. Scoring was considered acceptable when each rater independently scored the child's behavior within 1 point of the other rater on the expanded 10-point scale at least 80% of the time. For the pilot study, the two raters reached 83% agreement within 1 point on the scale, with 75% exact agreement (Kappa = .63).

To ensure reliability of the repeated measures during the actual study, a reliability check was conducted in Participant 1's home between the two raters during one observation of the baseline phase, and every 4th week of the remaining 11 weeks of the study. During the baseline observation, the two raters obtained 100% exact agreement on the scale (Kappa = 1.00). On the second subsequent treatment phase checks, reliability between the same raters was 100% within 1 point on the scale, and 33% exact agreement on the first check (Kappa = .14), with an exact agreement of 100% on the last reliability check (Kappa = 1.00). Interrater reliability checks were not performed on Participant 2 because it was believed that the presence of the second rater or a videocamera in the home would have considerably altered his behavior, affecting the validity of the data.

Procedure

During the baseline and treatment phases, all observation sessions and data collections were made in the children's homes by one rater, the first author. Efforts were made to keep observation times constant for each child, to coincide with the child's natural routine, and to control for the variability of the child's behavior commonly seen at different times during the day. A 2-week interim period between the initial evaluation and the initiation of treatment was used to collect the baseline data. The treatment phase consisted of sensory integrative-based occupational therapy for 1 hr once a week for 11 weeks for Participant 1 and for 7 weeks for Participant 2. Changes in target behaviors were recorded in the child's home by the rater, who was not the treating therapist. Because a minimum of 3 data points are recommended to establish a baseline trend (Barlow & Hersen, 1984), 8 baseline observations were taken for each participant. During the treatment phase, 16 observations were taken for Participant 1, and 13 were taken for Participant 2.

Treatment Provided

The theory and techniques used in all therapy sessions were consistent with the description of sensory integrative-based occupational therapy (Ayres, 1979; Koomar & Bundy, 1991). Depending on the individual sensory needs of each participant, a wide array of materials and activities were selected during the treatment period. Therapy equipment provided by the health center included several large pillows, a small trampoline, a trapeze bar, a suspended platform swing, a Lycra™ swing, “body socks,” a bounce pad, a child-sized table and chair, and a selection of textured and manipulative toys and activities. The treating therapist had been a practicing occupational therapist for 14 years and had 7 years experience practicing sensory integrative-based occupational therapy at the time of this study. Therapy in the clinic was child directed, with each participant actively making choices and then engaging in enjoyable, sensory-based activities. Gradually, the participant was encouraged to participate in nonthreatening activities that involved movement through space and multimodality input. This graded sequence of sensory and motor activities recognized the participants’ resistance to novel experiences and was designed to allow them to comfortably and slowly explore activities and gain new experiences (Koomar & Bundy, 1991; Nelson, 1984). The parents of each participant were provided with information about their child’s sensory processing abilities and were given opportunities to observe their child’s therapy at the outpatient clinic.

Data Analysis

After visual analysis of the trend, slope, and level of all dependent variables, serial dependency was calculated for the baseline and treatment phases of each dependent variable for both participants to determine whether data were significantly autocorrelated (alpha < .01). Demonstration of significant correlation between the points of some data sets made the conventional t and F test analyses inappr
appropriate and necessitated the use of an alternative method of analysis (Barlow & Hersen, 1984). When no visible trend was observed during the baseline phase of data collection, the two standard deviations band method was used to analyze the changes in level between the two phases of this design. With this method of analysis, when two or more consecutive data points are more than 2 standard deviations above or below the mean, the treatment is considered to have had a significant effect on the dependent variable. If a data set contained a baseline trend with a slope, a trend line analysis and a binomial test were used to indicate whether significant changes had been observed between the baseline and treatment phases for each participant.

Results

Participant 1

Eight baseline observations and 16 observations during the 11-week treatment phase were collected for Participant 1 (see Figure 1). Serial dependency was calculated for the baseline and treatment phases of each dependent variable. Although data points in the baseline phase were not found to be significantly autocorrelated (for an alpha level of .01) in any of the baseline phases, the treatment phases of all measures demonstrated significant serial dependency for this participant. When serial dependency was eliminated from each data set, the results remained significant. Raw data sets were then used for all subsequent statistical analyses because they reflected the true behaviors of each participant.

Participant 1 demonstrated major improvements in the areas of social interaction, approach to new activities, and response to holding and hugging during the treatment phase. As Figure 1 indicates, several confounding variables occurred during this study that may have affected his performance on the dependent variables. Between the first and second observations of the baseline phase, this participant was enrolled in a special education preschool program. However, because the preschool and baseline observations were begun almost simultaneously and because no notable improvements were noted until the sensory integrative-based occupational therapy was initiated, it is hypothesized that the confounding effects were minimal. Additionally, this participant began receiving speech therapy services during the 3rd week of the treatment phase. He attended four speech therapy sessions by the end of the study but had already begun to make noticeable improvements in all target behaviors by the time speech services began. In addition, Participant 1’s mother provided him with two vitamin regimens during the treatment phase. As noted in Figure 1, these programs were initiated in the 4th and 8th weeks of the treatment phase, after considerable treatment effects had already been established, so were assumed to have not considerably affected the study results.

Social interaction. During the baseline phase, Participant 1’s social interactions were limited by echolalic speech and poor initiation. He obtained an average baseline score of 3.88 (SD = .35) on the expanded 10-point scale. As seen in Figure 1, 14 consecutive points of the 16 data points collected during the treatment phase reflected significant improvements in social interaction. His social interaction skills improved in both frequency and complexity. By the end of the study, he consistently initiated conversations with others and, on occasion, was observed leading conversation and play activities. His caregivers were observed making conscious efforts to use therapy techniques at home, modeling appropriate behaviors and speech patterns, and providing opportunities for gross motor play that involved deep pressure input.

Approach to new activities. Participant 1’s behavior during baseline ranged from signs of distress and physical avoidance to reluctance and needing encouragement before approaching a new activity. His average baseline score for the measure of approach to new activities was 2.75...
(SD = .71). On visual inspection, the baseline data for this dependent variable demonstrated variance and a slight upward sloping trend (see Figure 1). A trend analysis indicated that 14 of the 16 data points in the treatment phase were above the extended trend line. A binomial test indicated that this improvement was significant (p < .002). Two weeks into the treatment phase of this study, the participant had progressed to needing only verbal encouragement and showed less hesitance and fear. By the final observation sessions, he was operating within normal expectations for a child his age without PDD, sometimes looking to his caregiver for reassurance but, on occasion, willingly approaching activities with no signs of reservation.

Response to holding and hugging. Children with autism typically display an aversion to or lack of interest in being held or cuddled by others, a particularly distressing characteristic of the disorder for many families. At the outset of this study, Participant 1 demonstrated tolerance of being held or hugged only if he was the one to initiate the activity. His response to holding and hugging remained relatively constant in the baseline phase (see Figure 1), with a mean of 3.88 (SD = .35). During intervention, he progressed to tolerating brief episodes of holding and hugging initiated by others. Analysis using the two standard deviations band method indicated that 13 consecutive points of the total 16 data points collected in the treatment phase demonstrated major improvements in his response to holding or hugging. By the final weeks of data collection, a mutually satisfying parent-child relationship had emerged, as the participant accepted being hugged and sometimes sought being held for comfort.

Participant 2

Eight baseline observations and 13 observations during the 7-week treatment phase were made for Participant 2 (see Figure 2). Serial dependency was calculated for the baseline and treatment phases of all dependent variables and was determined not to be significant (for alpha level of .01) for any of the data sets.

Participant 2 displayed significant, but gradual, gains in the measures of social interaction and response to movement during the treatment phase, reflecting the severity of symptoms he displayed at the outset of the study. The expanded 10-point scale was designed to reflect these incremental changes in behavior.

Social interaction. On one occasion of the baseline observations, Participant 2 did not attend to, or even seem aware of, the conversation of others. On all other baseline observations, he attended to the play and conversation of others by either looking or appearing to listen but never reciprocally engaging in the activity. The average score during the baseline phase of this measure of social interaction was 1.85 (SD = .35) (see Figure 2). Baseline data demonstrated little variance, and the two standard deviations band method of analysis indicated that 8 of the 13 data points in the treatment phase represented a significant improvement in social interaction. By the 2nd week of treatment, he demonstrated the ability to imitate and mimic the movements of others, representing a significant improvement in social awareness and interaction.

Functional communication during mealtime. No significant changes were observed in this participant's ability to communicate his wants or needs to his mother during snacktime through use of gestures, sign language, or speech. He used physical guidance to indicate that he was hungry or to ask for a specific snack. Baseline measures of his functional communication skills demonstrated an average score of 2.75 (SD = .46), and represented a relatively stable performance (see Figure 2). Analysis indicated that none of the 13 data points during treatment were more than 2 standard deviations above or below the baseline mean, showing no significant difference between the base-
line and treatment phases for this dependent variable. It is important to point out, however, that this participant had a very limited number of foods that he would eat, and it was frequently difficult to entice him to eat at all, much less to elicit communication requesting food.

Response to movement. This variable represents a particularly disruptive aspect of Participant 2's behavior that improved significantly over the course of this research. Before this study, his family members had installed a swing and a climbing structure in the children's play room to fulfill his constant need for movement. The average score for the baseline observations of Participant 2's response to movement was 1.63 (SD = .52) (see Figure 2). With the two standard deviations band method of analysis, 11 of the 13 data points in the treatment phase indicated significant improvement in response to movement. After 3 weeks of therapy, the participant was consistently able to sit and briefly attend to a video, and on two occasions, although still evidencing a preference for movement activities, he was able to be guided into more sedentary activities for a longer period.

Discussion

The results of this study may have implications for the clinical application of sensory integrative-based occupational therapy for preschooers with PDD. Both participants demonstrated significant gains in all functional behaviors observed in the natural context of the home, with the exception of Participant 2's functional communication during mealtimes. These results support Jang's (1996) conclusion that the application of sensory integrative-based occupational therapy may enhance the behavioral responses of children with autism. In addition, the results may support the findings of Ayres and Tickle (1980), who asserted that sensory integrative-based occupational therapy was more effective for children with autism who demonstrated hyperresponsiveness rather than hyporesponsiveness to sensory input. Baseline observations of Participant 1 and his parent interview indicated that he displayed signs of hypersensitivity to many stimuli (e.g., clothing, food, touch, sound). On the other hand, Participant 2 displayed signs of hypersensitivity to certain stimuli (e.g., tactile) but frequently demonstrated hyporesponsivity by not attending or responding to sensory input (e.g., vestibular stimulus). Although Participant 2's response to treatment was significant in two of the three target behaviors, his functional gains appeared minimal compared with Participant 1. According to sensory integrative theory, children who register and process sensory information efficiently are able to adapt their motor and behavioral responses to environmental demands. Results of this study suggest that Participant 2, the child who had more difficulty registering some sensory input, was generally less responsive to sensory integrative-based occupational therapy than was Participant 1.

Neither participant demonstrated self-stimulating behaviors as described by McClure and Holtz-Yotz (1991) and Zisserman (1991). However, both participants displayed an extremely high level of gross motor activity (e.g., running, jumping, swinging), and, as indicated by baseline measurements of Participant 1's approach to new activities and Participant 2's response to movement, these behaviors were frequently disruptive. During the course of the study, reductions in the frequency and duration of these disruptive behaviors and progression toward more functional behaviors (e.g., attending to activities and conversation, purposeful play) were observed in both participants.

The results of this study support the underlying assumption of sensory integration theory that when children can modulate and regulate sensory information, they more easily reach and maintain an optimal behavioral state to engage in social interaction and participate in developmentally appropriate activities (Ayres, 1972, 1979). After receiving sensory integrative-based occupational therapy, Participant 1 was better able to process and integrate tactile information and was then able to respond more adaptively to touch in the form of hugging and holding. Similarly, after receiving the program of sensory integrative-based occupational therapy, Participant 2 was able to modulate and process vestibular input more effectively and then demonstrated a decreased need for movement at home. While receiving sensory integrative-based occupational therapy, both participants were observed to more effectively process and integrate sensory information to form appropriate behavioral and motor responses, leading to functional outcomes in the home.

Limitations and Directions for Future Research

The generalizability of these results is limited by the single-subject design. Only two participants were included because of the availability of children who fit the inclusion criteria. The validity of these results may have been affected by the occurrence of confounding interventions (e.g., preschool, vitamin regimen) during the treatment phase of this study. Additionally, because of ethical concerns, the A-B single-subject design was chosen instead of the A-B-A design. Future research endeavors should involve a larger sample, allow for a longer treatment period, and include a return to baseline phase (A-B-A design) in order to provide documentation of the functional outcomes of this intervention.

Summary and Implications for Occupational Therapy

This study explored the application of sensory integrative-based occupational therapy with two children representing the varied continuum of deficits observed in PDD.
Throughout the carefully graded therapy program provided by an experienced clinician, improvements in functional behaviors were documented in the children's homes, where treatment effects are most critical and functional. Improvements were noted in the areas of social interaction, approach to new activities, response to holding and hugging, and response to movement. Documentation such as this, which captures the functional outcomes of intervention, has important implications for reimbursement in health care.

Conclusion

A carefully implemented program of sensory integrative-based occupational therapy led to gains in functional behaviors in these two pre-school-age boys with PDD. These improvements were incrementally measured and documented using an expanded 10-point version of the Functional Behavior Assessment for Children with Sensory Integrative Dysfunction. Although the two participants displayed differences in the severity and types of symptoms they expressed, this scale captured the varied continuum of their behaviors and provided an appropriate tool for measuring the treatment outcomes. Significant improvements were noted in the areas of social interaction, approach to new activities, response to holding and hugging, and response to movement. Although future research is needed to replicate and extend these findings, the significance of these results allows for the conclusion that a program of sensory and integrative-based occupational therapy, when used with persons with PDD, may lead to improved functional behaviors in the natural context of the home.

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References


