
Immediate Effect of Ayres's Sensory Integration–Based Occupational Therapy Intervention on Children With Autism Spectrum Disorders

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KEY WORDS

- A. Jean Ayres
- autism spectrum disorders (ASDs)
- pediatric
- sensory integration

OBJECTIVE. This study examined the effects of Ayres's sensory integration intervention on the behavior and task engagement of young children with autism spectrum disorders (ASD). Clinical observations and caregiver reports of behavior and engagement also were explored to help guide future investigations.

METHOD. This single-subject study used an ABAB design to compare the immediate effect of Ayres's sensory integration and a play scenario on the undesired behavior and task engagement of 4 children with ASD.

RESULTS. No clear patterns of change in undesired behavior or task management emerged through objective measurement. Subjective data suggested that each child exhibited positive changes during and after intervention.

CONCLUSION. When effects are measured immediately after intervention, short-term Ayres's sensory integration does not have a substantially different effect than a play scenario on undesired behavior or engagement of young children with ASD. However, subjective data suggest that Ayres's sensory integration may produce an effect that is evident during treatment sessions and in home environments.

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Recent estimates suggest that the incidence of autism spectrum disorders (ASD) in the United States is approximately 6 per 1,000 children, equating to around 114,000 children younger than age 5 years (Fombonne, 2003). Children with ASD often demonstrate undesirable behaviors such as stereotypic motor movements, aimless running, aggression, and self-injurious behaviors (Filipek et al., 1999). Children engaged in undesired behaviors are not available to engage in or learn from therapeutic activities (Harris & Wolchik, 1979; Smith, Press, Koenig, & Kinnealey, 2005). *Engagement* refers to an individual's interaction with the social and nonsocial environments (McWilliam & Ware, 1994). Engagement is a central component of participation, an important aspect of occupation that is emphasized by the World Health Organization (WHO, 2001) and the American Occupational Therapy Association (AOTA, 2002). Research shows that children with ASD spend less time engaged than children without disabilities (McGee, Daly, Izeman, Mann, & Risley, 1991). High levels of active engagement in instructional and therapeutic activities have been shown to be crucial in effective intervention for children with ASD (Dawson & Osterling, 1996).

Occupational therapists are skilled at providing intervention designed to foster engagement in their clients with disabilities (AOTA, 2002) and this intervention may take many forms. One method occupational therapists commonly report using with persons with ASD is sensory integration–based occupational therapy, or Ayres's sensory integration (Case-Smith & Miller, 1999; Watling, Deitz, Kanny, & McLaughlin, 1999).

Ayres's sensory integration is multifaceted and difficult to reduce to component parts or define operationally (Ottenbacher, 1991). Originally developed by A. Jean Ayres (1972), the classic sensory integration approach is based on the understanding that disruptions in neurological processing of sensory information interfere with the production of organized and purposeful behaviors that provide the foundation for learning and skill development. Ayres's sensory integration enhances nervous system processing of sensation to provide a stable foundation for the formulation and execution of appropriate behavior (Ayres, 1972; Bundy, Lane, & Murray, 2002). Classic Ayres's sensory integration uses enhanced sensory experiences in the context of meaningful, self-directed activity to support a person's ability to function adaptively and meet the contextual demands of daily occupations. Because vestibular, proprioceptive, and tactile sensations have powerful effects on the regulatory mechanisms of the nervous system (Kandel, Schwartz, & Jessell, 2000), Ayres's sensory integration uses these sensations to facilitate production of adaptive behavior (Bundy et al., 2002). When using Ayres's sensory integration, occupational therapists use clinical reasoning to guide the intervention process, individualizing the approach to match each child's unique sensory processing abilities and challenges.

At present, the literature includes only three studies that used methods consistent with Ayres's sensory integration with persons with ASD. Ayres and Tickle (1980) reported improvements in interaction, initiation, environmental awareness, and activity selection after 11 months of Ayres's sensory integration for persons with ASD who had average or hyperresponsive reactions to tactile and vestibular sensations. Linderman and Stewart (1999) identified gains in social interaction, response to movement, approach to new activities, and response to holding and hugging for 2 children with ASD who received Ayres's sensory integration. Case-Smith and Bryan (1999) reported improvements in mastery play and adult interaction and decreases in non-engaged behaviors for 5 preschoolers with ASD who participated in individualized Ayres's sensory integration and whose teachers received consultation from the occupational therapist. These findings suggest that Ayres's sensory integration may be an effective strategy for decreasing behaviors viewed as nonengagement (e.g., wandering, unfocused staring, stereotypy, spinning) and increasing engaged behavior (e.g., goal-directed interaction) among preschool-age children with ASD.

With so few studies examining Ayres's sensory integration for children with ASD, conclusions regarding the effectiveness of the intervention cannot be drawn. In reviews of the literature, both Dawson and Watling (2000) and Gold-

stein (2000) concluded that well-controlled studies with relevant and reliable outcome measures are needed to expand our knowledge of the effectiveness of Ayres's sensory integration. Goldstein (2000) stated that Ayres's sensory integration remains under development and that, as such, efficacy studies should include "well-controlled single-subject design experiments with a few subjects" (p. 424). This study used single-subject research methodology as a first step in answering this charge.

The primary purpose of this study was to examine the effectiveness of Ayres's sensory integration compared to a play scenario for (a) reducing undesirable behaviors and (b) increasing engagement in purposeful activities for young children with ASD. A second purpose of the study was to record subjective data that may guide future research in this area. The research questions were (a) Does participation in Ayres's sensory integration immediately before tabletop tasks affect the occurrence of undesired behaviors during the tabletop activities? and (b) Does participation in Ayres's sensory integration immediately before tabletop tasks affect engagement in tabletop activities? A tabletop paradigm was used because it is congruent with situations frequently encountered by young children in the occupation area of education. Further, the tabletop paradigm provided a standardized environment for data collection.

Method

Design

An ABAB design (Kazdin, 1982) was used because it provides a mechanism for examining the effect of the intervention for each participant. The effect of the intervention is measured by comparing the client's performance in the no-treatment condition (A phases) to that in the treatment condition (B phases). This study also incorporated a familiarity phase to allow participants to become familiar with the occupational therapist, environment, and study protocol before data were collected. The familiarity phase was included to reduce the effect of novelty on the dependent variables.

Participants

Four boys between ages 3 years, 0 months, and 4 years, 4 months, participated in this study. All had been independently diagnosed with ASD before being referred for the study; the criteria for their diagnoses were not known. Eligibility criteria included no comorbid diagnoses, absence of seizures, no concurrent occupational therapy services, and no intention to add or change medications or therapy services during the course of the study.

Setting

This study was carried out in a clinic environment at a university. The intervention room contained a small table and two chairs, large cushion, floor fan, wall-mounted mirror, and scooterboard ramp. The carpeted floor of the room was covered with mats throughout the study. For the tabletop activity segments, vertical room dividers were positioned to enclose the table and chairs.

Personnel

All study sessions were conducted by an occupational therapist with more than 12 years' experience using Ayres's sensory integration with young children with ASD. The research assistant was a master's-level student in speech-language pathology who had experience working with children with ASD. She had no prior exposure to Ayres's sensory integration, and she was blind to the purpose of the study. The research assistant videotaped all study sessions, completed portions of the procedural reliability checklist, and entered her observations in the study log. Three pediatric occupational therapists with training in Ayres's sensory integration and practice experience ranging from 1 year to 16 years served as data collectors.

Materials

Materials for the baseline phases were chosen for each child according to developmental level and child preferences as reported by the caregiver. They were judged by an early childhood expert to be representative of activities that typically are available in preschool environments. Materials for the treatment phases included items that commonly are used in Ayres's sensory integration, for example, suspended equipment such as swings, trapeze bar, and rope ladder; a small trampoline; scooterboard and ramp; plastic rings; tunnel; balance beam; toys with various textures; and toys that challenge bilateral coordination and manipulation skills (Ayres, 1972; Bundy et al., 2002).

Ten developmentally appropriate activities were identified for each child for the tabletop activity segments through a collaborative effort of the primary investigator and the child's caregivers. Activities had to meet two criteria: (a) the activity demands matched the cognitive and fine motor skills of the child, and (b) the activity had the tendency to elicit focused attention and purposeful engagement. An early childhood education expert confirmed that each activity represented activities typically encountered in early childhood education environments. Examples of activities were puzzles, stickers, figurines, beads and string, and blocks. None of the toys used in the tabletop segments were the same as those used in baseline or treatment sessions for any child.

Dependent Variables

Using the approach described by Kazdin (1982) and Deitz (2006), target behaviors were selected and operationally defined and strategies for assessment were identified. This process was completed for both undesired behavior and engagement. In this process, an interdisciplinary team was consulted, literature was reviewed, and pilot ratings were completed to ensure the relevance and repeatability of these measures. Interrater agreement was checked both before data collection and throughout the data collection process.

Undesired behavior. Undesired behavior was defined as those behaviors that interfere with task engagement and participation in daily activities. Two processes were used to operationalize undesired behavior for coding. First, undesired behaviors commonly observed in ASD were identified through a literature review. Next, each child's unique undesired behaviors were identified through caregiver report and observation by the primary investigator during the familiarity period of the study. This information was combined to produce a list of undesired behaviors that might be displayed by the participants during data collection. Data collectors referred to this list to judge whether participants displayed undesired behavior during the tabletop activity segments. For 42% of the completed data collection forms, interobserver agreement for undesired behavior was calculated using the point-by-point method (Kazdin, 1982). Agreement for undesired behavior ranged from 85% to 100%, with a mean of 91%.

Engagement. Engaged behavior was defined as intentional, persistent, active, and focused interaction with the environment, including people and objects. This definition purposefully did not require typical use of the tabletop materials to capture all interactions that held meaning for each child. Participant behaviors were coded as *engaged* if an object was used in a manner that was clearly playful or imaginative and that appeared to have meaning to the child. For example, when a child used a marker to color on his hand and directed his gaze toward his coloring, his behavior was coded as *engaged*. When a child bit or chewed on a marker while looking across the room, his behavior was coded as *not engaged*. Again using 42% of the completed data collection forms, interobserver agreement for engagement was calculated using the point-by-point method (Kazdin, 1982). Agreements for engagement ranged from 81% to 100%, with a mean of 95%.

Procedures

Recruitment and Screening

Staff members at local neurodevelopmental centers described the study to caregivers of children with ASD who

were on waiting lists to receive occupational therapy services. Interested caregivers contacted the principal investigator. Before enrollment in the study, each child's caregiver was interviewed by phone to confirm a diagnosis of ASD and occupational therapy referral. A follow-up appointment in the child's home involved completion of the Sensory Profile (Infant/Toddler or Child version; Dunn, 1999; Dunn & Daniels, 2002); a caregiver interview to collect descriptive data about the child's typical daily activities, engagement and behavior patterns, preferred activities, intervention history, and demographics; and observation of the child's engagement and behavior in the natural environment. Sensory Profile Quadrant scores, caregiver report of restricted engagement and undesired behavior, and observation of restricted engagement by the principal investigator guided decisions about eligibility for the study. Participant characteristics are described in Table 1. All names are pseudonyms.

Activity Randomization

The baseline and tabletop toys for each child were independently listed in alphabetical order then numbered sequentially from 1 to 10. A random-numbers table containing the numerals 1 through 10 was used to develop toy presentation lists for the baseline and tabletop activity segments for each child. Use of these lists is described below.

Study Sessions

This study had three phases: familiarization, baseline, and treatment. Each phase of the study included three 40-min intervention sessions per week. Each session was followed by a 10-min tabletop activity segment that served as the data collection period.

The familiarization phase comprised three sessions in which the child and occupational therapist spent 15 min in free play using toys from the child's list of baseline activities

Table 1. Summary of Participant Characteristics

Child	Age	Intervention History	Functional Communication	Sensory Profile Score	Caregiver Engagement Description	Undesired Behaviors
*Antoine	3 years, 11 months	Preschool 4x/wk Speech therapy 40 min/wk school 1 hr/wk clinic No OT during study	No functional use of words or signs	Sensory Seeking Sensory Sensitivity Sensation Avoiding	Plays alone Throws toys Shreds paper Chews toys Attention less than 1 min	Shows aggression Licks/mouths self or objects Lifts hand to side of face Repetitive movements
*Billy	4 years, 4 months	Preschool 4x/wk Speech therapy 20 min/wk school 1 hr/wk clinic OT 10 min/wk school No OT during study	Uses multiword utterances, which are often scripted or echolalic; speech is repetitive when anxious	Sensory Seeking Sensory Sensitivity Sensation Avoiding	Prefers to play alone Uses other people as props Imitates scenarios from movies Is obsessive with repetitive books Acts out sports actions (e.g., golf) Has tantrums with transitions Enjoys using computer	Lines up objects Squints eyes Visually inspects objects Hits one toy with another Gazes from corner of eyes Repetitive use of toys
**Charles	3 years, 0 months	0-3 program 2x/wk Speech therapy 1 hr/wk clinic 4 OT sessions before study No OT during study	Single words emerging in echolalic manner; imitates a few signs	Low Registration Sensation Avoiding	Rolls balls down stairs Follows older brother around Lines up figurines Plays in dirt outside	Lines up objects Pushes one toy with another Repetitive movements
*David	3 years, 8 months	Preschool 4x/wk Speech therapy 20 min/wk school 1 hr/wk clinic OT consult at school No OT during study	No functional use of words or signs	Sensory Seeking Sensory Sensitivity Sensation Avoiding	Prefers to jump, run, swing Plays with leaf, straw, bandage No traditional play Attention less than 30 seconds	Mouths/bites objects Rubs things on face Scratches self or objects Moves things along table Flaps hands Flicks or pats objects Throws objects

*Sensory Profile scores are those quadrants for which study participants scored "more than others" using the expanded cut scores for children ages 3-10 years (Dunn, 2006) and indicate that the child is performing more than 2 standard deviations below the mean when compared with same-age children without disabilities.

**Scores are from the Infant/Toddler Sensory Profile (Dunn & Daniels, 2002).

Note. OT = occupational therapy.

and an additional 15 min using activities typically used in Ayres's sensory integration (Ayres, 1972; Bundy et al., 2002). The order of the baseline and Ayres's sensory integration conditions was alternated across the familiarization sessions.

The baseline sessions were designed to be similar to the free-play scenarios typical of preschool environments. During each baseline session, the first five activities on the baseline activity presentation list were placed in the study room. The occupational therapist used comments, gestures, and demonstrations to encourage the child to select and engage with the available materials. She followed the child's behavioral cues and communication to guide her participation. The therapist made every effort for her demeanor and interactions during the baseline sessions to parallel those during the intervention sessions to reduce the possibility that differences in therapist-child interaction would affect the child's behavior during the tabletop activity segment. On the next baseline session day, the next five activities on the baseline activity presentation list were available to the child, and so on for each day in the baseline phases of the study.

The activities selected for the Ayres's sensory integration sessions with each child were based on the Sensory Profile (Dunn, 1999) results, caregiver information, and clinical observations. Throughout each Ayres's sensory integration session, the occupational therapist used clinical reasoning (Burke, 2001) to guide her actions and interactions with the participants. Knowledge of sensory integration theory, observations of the child's behaviors, and previous experiences with Ayres's sensory integration and children with ASD helped to develop understanding of the child and his occupational performance. This process guided material selection, environmental modifications, therapist-participant interaction, and provision of support during each session of Ayres's sensory integration. Clinical reasoning was used to decide how many and which pieces of suspended equipment to make available, when to offer new activities, and how to increase or decrease challenge in the activities engaged in by the participants. The therapist continually observed the child's responses to activities and made modifications as needed to offer an appropriate level of challenge that encouraged development of new skills.

During the tabletop activity segments, the first four activities on the tabletop activity presentation list were presented in order. The therapist placed the first activity on the table, said, "Look, time to do [name of activity]," and demonstrated typical use of the task materials. Then she offered the materials to the child and set a timer for 2 ½ min. After 1 min, the therapist stated, "My turn" and gave another demonstration. When the timer signaled after the final 1 ½ min, the therapist said, "The [name of activity] is

all done, now it's time for [name of next activity on list]" and exchanged the toys on the table. The sequence was repeated until the child had the opportunity to engage for 2 ½ min with each of four toys. On the next study day, the next four activities on the tabletop activity presentation list were presented, and so on for each day of the study.

Data Collection

All study sessions were videotaped. A separate videotape of each tabletop activity segment was made for each dependent variable. The 10-min videos were divided into intervals for rating. Undesired behavior was rated in 10-second intervals, and engagement was rated in 3-second intervals. Auditory tones indicating the start of each observation interval were recorded onto the videos. Using videotapes of children who did not participate in the study, two data collectors were trained to rate the occurrence of the dependent variables using a partial interval scoring method (Kazdin, 1982). The target behavior was rated as having occurred if it was observed at any time during an interval. The raters independently viewed each videotape one time to rate undesired behavior, and they independently viewed the tape a second time to rate engagement. The raters continued training until they reached 95% interrater agreement for each dependent variable. The study videotapes were independently viewed and rated using these same methods (Kazdin, 1982). For each tabletop segment, the number of intervals in which the dependent variable occurred was summed. Data collectors were blind to which condition preceded the tabletop segments displayed in the videotapes.

Clinical observations of each child's behavior and social interactions were recorded in separate study logs by the occupational therapist and the research assistant. In addition, caregivers provided written weekly reports of their children's behavior and engagement in their home environments.

Data Analysis

The data were graphed separately for each participant and each dependent variable. Data were interpreted through visual inspection because it is the most frequently used method of data analysis for single-subject research (Baer, 1977; Kazdin, 1982) and because visual inspection increases confidence that observed performance changes are due to the intervention (i.e., changes must be large enough and clear enough to see without the use of inferential statistics; White, 2001).

Data in the study log were reviewed subjectively to gain insights into the observations of the research assistant and occupational therapist. The weekly reports of participant behavior and engagement in the home environment also

were reviewed. Formal analysis of these data was not possible due to lack of consistency in the content of the data.

Reliability

Procedural reliability (Billingsley, White, & Munson, 1980) was assessed using a checklist developed for this study that identified all set-up, toy presentation, data collection, and behavior management procedures. For each session, procedural reliability was calculated by multiplying the number of therapist behaviors emitted in accordance with the plan by 100 and dividing the total by the total number of therapist behaviors that could have been emitted in accordance with the plan. Mean daily procedural reliability was above 99% for all phases.

Fidelity to treatment was assessed via post-hoc use of the pilot version of the Observation of Intervention Using Ayres's Sensory Integration Principles (OASI; Parham, Cohn, Koomar, & Miller, 2004), a tool designed to assess whether intervention sessions in research studies adhere to the core principles of Ayres's sensory integration. For the pilot version of the tool, preliminary interrater reliability was weak for 3 of the 10 items. Validity data showed that the OASI was effective at differentiating among a range of intervention processes when used to rate videotapes of intervention sessions (Parham, 2004).

The data collectors were trained to use the OASI until they achieved 95% interrater agreement for overall session ratings. After training, the raters independently rated videotapes of both baseline and treatment sessions. A score of 80 (out of 100) was required for a session to be considered Ayres's sensory integration (Parham, 2004). Eight of 38 baseline videotapes (21%) were randomly selected and rated using the OASI. Scores ranged from 15 to 30, confirming that these sessions were not Ayres's sensory integration. Using OASI overall session scores, the interrater agreement for the baseline sessions was 100%. Fifteen of 80 treatment sessions (18.7%) were randomly selected and rated using the OASI. Scores ranged from 90 to 100, suggesting congruence between the treatment provided and the OASI criteria for Ayres's sensory integration. Twelve of the 15 tapes rated for fidelity were rated by two observers to determine interrater agreement. Using overall session scores for the OASI, interrater agreement was 100%.

Results

Each child participated in a different number of study sessions due to absences and different enrollment dates. Antoine participated in 32 sessions, Billy in 31, Charles in 33, and David in 34 (see Figures 1 and 2). Each day of participation is represented by a dot on the graphs. Connected

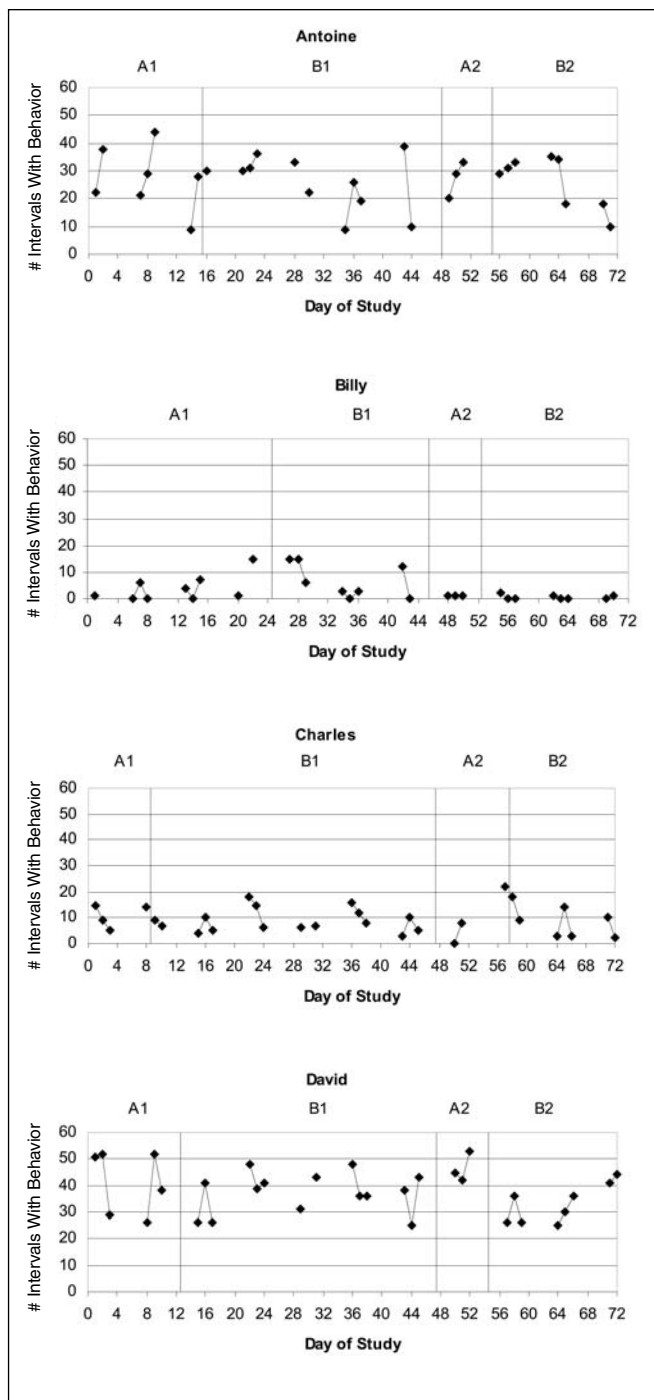


Figure 1. Data for undesired behavior in the clinic setting immediately after Ayres's sensory integration for each participant.

dots represent consecutive days of participation. Unconnected dots represent gaps between days of participation due to absences or non-study days.

Undesired Behavior

For all participants, there was considerable overlap in the number of intervals that undesired behavior was observed in the baseline (A) and intervention (B) phases. Antoine's lowest rates (fewer than 20 intervals) of undesired behavior occurred on a greater percentage of days in the B phases

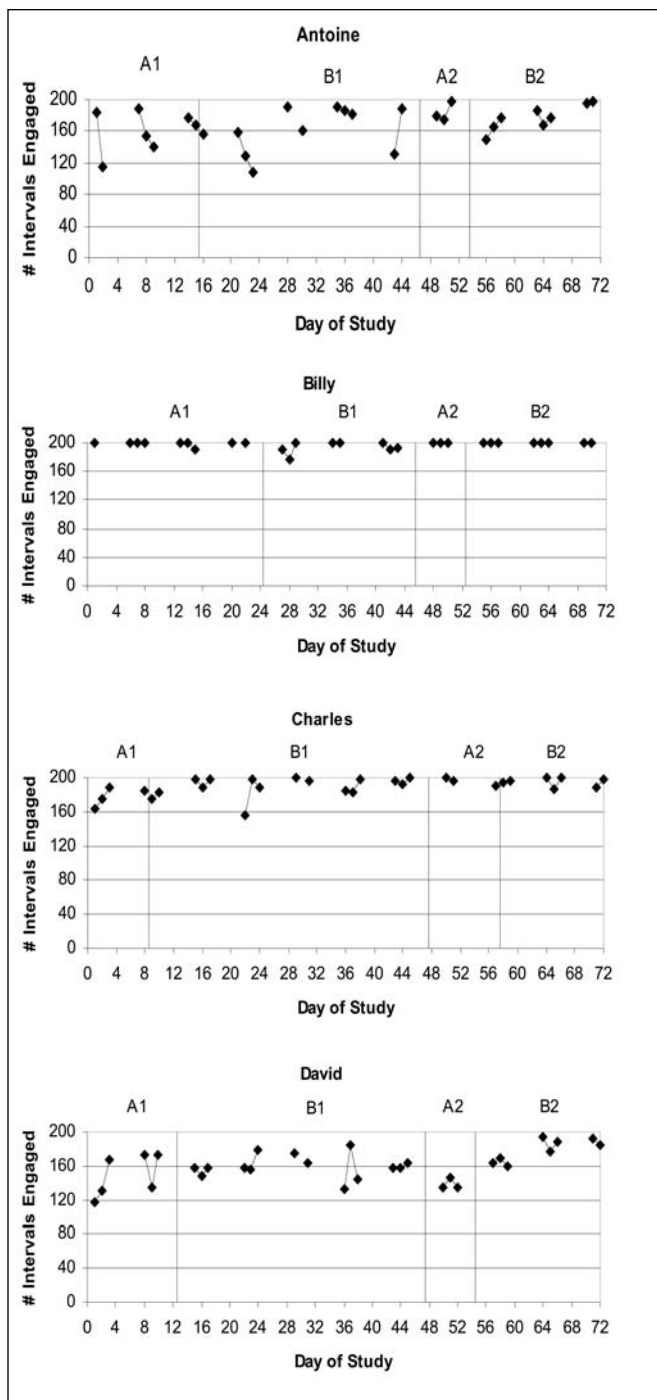


Figure 2. Data for engagement in the clinic setting immediately after Ayres's sensory integration for each participant.

(32%) than the A phases (10%). His rates of undesired behavior in the B phases were within the range of scores observed in the A phases. Billy's highest rates of undesired behavior occurred at the end of A1 and the beginning of B1, followed by a decrease midway through B1. Almost no undesired behavior was observed in A2 and B2. Charles also had very low levels of undesired behavior throughout the study, with overlap of scores observed across all phases. David displayed highly variable undesired behavior in all phases. Overall, he had a greater percentage of days with

low rates (fewer than 40 intervals) of undesired behavior in the B phases (64%) compared with the A phases (33%). Definitive conclusions about the effect of Ayres's sensory integration on the undesired behavior of these children cannot be drawn due to the overlap of scores across the A and B phases.

Engagement

Visual analysis of the data indicates relatively high engagement for all participants, with scores that overlap in all phases of the study. Antoine's rates of engagement varied widely during A1 and B1. His rates were less variable during A2 and B2 and were on average higher. Except for one data point in B2, all data points in the last two phases were above 160 intervals. Billy's rate of engagement reached the ceiling of the measure on the first day of data collection and continued at very high rates throughout the study. Charles also had high rates of engagement (157–200 intervals), with no substantial differences between the A and B phases. For David, B2 was the only phase in which all data points were at or above 160 and was the phase in which he demonstrated his highest rates of engagement. Moreover, there was a shift in level from A2 to B2, with no overlap of scores between A2 and B2. Overall, David demonstrated his highest rates of engagement (more than 160 intervals) on more days in the intervention phases (55%) than the baseline phases (33%).

Subjective data recorded in the study logs suggest that new behaviors emerged during the Ayres's sensory integration sessions for each participant. Antoine demonstrated increased vocalizations, eye contact, and socialization as well as improved transitions and choice making. Billy's tolerance for transitions increased, he was more responsive to therapist instructions, and he had greater initiation of and engagement in activities that presented motor challenges. Charles's protesting and withdrawal behaviors decreased, and his compliance, interaction, language, and flexibility during transitions increased. David demonstrated more functional use of toys, more initiation, improved transitions, increased social interaction, and longer duration of engagement.

Subjective reports of the caregivers suggested that changes also occurred in participants' behaviors in the home environments. Antoine's caregiver reported more social participation, more compliance, and improved independence in dressing. Billy was reported to be more patient, better able to request assistance when needed, and more compliant with instructions. Charles reportedly demonstrated more social play. David's caregiver reported a decrease in aggression accompanied by an increase in eye contact, longer duration of toy play, and improved compliance.

Discussion

The primary purpose of this study was to evaluate the immediate effect of Ayres's sensory integration as an intervention for decreasing undesired behavior and increasing task engagement among young children with ASD. When effects were measured after intervention, short-term Ayres's sensory integration did not have a substantially different effect from that of a play scenario on the undesired behavior or engagement of the children in this study. A secondary purpose was to gain insight into the subjective observations of research personnel and caregivers as a way of identifying possible indicators of change that could guide future research. The data gathered from these sources suggested that Ayres's sensory integration had a positive effect on transitions, socialization, compliance, and general behavior regulation that was evident during the intervention sessions and in the home environments. These data should be viewed cautiously because of the possibility of bias.

Behavior

Clinical research has shown that undesired behaviors interfere with a person's ability to function independently and must be addressed before improvements in function can be made (Harris & Wolchik, 1979). The present study found that the rates of undesired behavior immediately after Ayres's sensory integration were similar to those after play conditions. However, parent reports and research personnel observations suggest that some changes did occur in the nature of the behavior exhibited by all study participants during Ayres's sensory integration and at home after Ayres's sensory integration. For example, parents reported that Antoine, Charles, and David demonstrated increased social interaction and that all participants demonstrated improvements in transitions between activities. These reports provide insight into the types of changes that may be produced by Ayres's sensory integration and suggest that qualitative measurement methods might better capture the effects of Ayres's sensory integration on behavior.

The results of this study are consistent with those reported by Smith et al. (2005), who found no change in frequency of undesired behaviors immediately after Ayres's sensory integration. In their study, data collected 1 hr after treatment indicated that undesired behaviors decreased an average of 11%, suggesting that the effect of Ayres's sensory integration on behavior may be more evident after a latency period. Similarly, caregivers in the present study reported positive changes in their children's behaviors in the home environment, suggesting that there was some positive effect after the treatment. The possibility of changed behavior in

the home environment merits further investigation under controlled conditions.

Engagement

Although findings for engagement generally did not support the use of Ayres's sensory integration over participation in play activities, results for David were interesting. David demonstrated his highest rates of engagement on 4 of the last 5 days of the study, suggesting that his task engagement improved over time. However, because David was concurrently participating in an applied behavior analysis (ABA) program, it is possible that this change was a result of the ABA program or the combination of the two interventions.

Short observation intervals were used to rate engaged behavior. As the study progressed, it became evident that the short observation intervals limited the ability to judge engagement in context and over time. Episodes that began as purposeful engagement sometimes developed into stereotypical or repetitive activity. These episodes were rated as engaged until it became clear that the behavior was stereotypical (often after 10 seconds or more), which likely inflated some of the engagement ratings. Another possible reason for the high rates of engagement is that the tabletop activity segments were highly structured and had a predictable sequence of events, elements known to support optimal performance of persons with ASD (National Research Council, 2001). Finally, the definition of engagement used in this study did not require traditional use of materials for a behavior to be rated as engaged. At times, each participant used materials in a nontraditional fashion and was rated as engaged as long as the criteria in the operational definition were met. This inclusion of nontraditional material use likely exaggerated the engagement ratings. Although the engagement ratings possibly were exaggerated, this possibility existed for both the baseline and intervention conditions, thus minimizing potential effects on the outcome of the study.

Strengths and Limitations

This study had four primary strengths. First, the study was carried out in a systematic manner and the treatment sessions met proposed criteria for Ayres's sensory integration. Second, both interventions were carried out by the same occupational therapist, controlling the effect of therapist characteristics on the therapist-participant interaction. Third, the raters for engagement and undesired behavior were blind to which intervention condition preceded the data collection period. Fourth, the study had high interrater agreement on the dependent variable ratings and high procedural reliability.

The primary limitation of this study relates to the constraints imposed by the operational definition of engagement. Although appropriate steps were followed in the process of defining and measuring engagement in young children with ASD, the measure may have provided an overestimate of engagement. Other limitations were the small sample size, complications in rating engagement, short duration of the A2 phases, and the potential for bias in subjective observations recorded by study personnel and caregivers.

Future Directions

Future research examining the effectiveness of Ayres's sensory integration for persons with ASD includes two key areas: (a) measuring the effects of Ayres's sensory integration during intervention sessions and (b) examining whether the effects of Ayres's sensory integration reported by the caregivers in this study consistently carry over to home and community settings for other children. Refinements in measurement and study design also are important. First, the measure of engagement should be refined, possibly focusing only on "appropriate engagement" and extending each observation interval to 15 to 20 seconds to ensure that ratings are based on sufficient time intervals to capture the complexity of purposeful engagement. Second, use of a randomized controlled trial with a longer intervention phase is recommended, as is measurement of outcomes both immediately after intervention and after a latency period. Only by refining the measurement strategies and research approach can we hope to definitively answer questions regarding the effectiveness of Ayres's sensory integration.

Clinical Significance

Ayres's sensory integration is commonly used by occupational therapists working with children with ASD. This study suggests that, although the intervention did not produce substantial changes in rates of engagement or undesired behavior immediately after the treatment, Ayres's sensory integration may have an effect on some characteristics of child behavior and engagement concurrently with the intervention sessions and after a latency period. In light of these possibilities, therapists using Ayres's sensory integration are advised to adjust expectations about when treatment effects may be observed and what sort of effects to expect. For example, when evaluating outcomes as a result of Ayres's sensory integration, occupational therapists should not expect dramatic changes in engagement or behavior to occur immediately after treatment. Rather, therapists should collect data on the subtle nuances of children's behavior, including compliance, socialization, ease of transition, and general behavior regulation both during and

after intervention. Further, we strongly recommend that occupational therapists using Ayres's sensory integration conduct objective measures of each child's baseline performance in addition to ongoing measurement of performance throughout the course of intervention to make judgments about whether the intervention approach being used is producing the desired effect for the individual child. ▲

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