Efficacy of Occupational Therapy Using Ayres Sensory Integration®: A Systematic Review

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This systematic review addresses the question "What is the efficacy of occupational therapy using Ayres Sensory Integration® (ASI) to support functioning and participation as defined by the *International Classification of Functioning, Disability and Health* for persons with challenges in processing and integrating sensory information that interfere with everyday life participation?" Three randomized controlled trials, 1 retroactive analysis, and 1 single-subject ABA design published from 2007 to 2015, all of which happened to study children with autism, met inclusion criteria. The evidence is strong that ASI intervention demonstrates positive outcomes for improving individually generated goals of functioning and participation as measured by Goal Attainment Scaling for children with autism. Moderate evidence supported improvements in impairment-level outcomes of improvement in autistic behaviors and skills-based outcomes of reduction in caregiver assistance with self-care activities. Child outcomes in play, sensory–motor, and language skills and reduced caregiver assistance with social skills had emerging but insufficient evidence.

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In the United States, approximately 5%–16% of children are reported to have difficulties processing and integrating sensations that affect their participation in activities of daily living (ADLs; Ahn, Miller, Milberger, & McIntosh, 2004; Ben-Sasson, Carter, & Briggs-Gowan, 2009). The incidence of sensory processing problems in children with disabilities such as autism spectrum disorder (ASD), at an estimated 56%–70%, is much higher (Baranek, David, Poe, Stone, & Watson, 2006; Ben-Sasson et al., 2007). The literature supports the relation between difficulties with processing and integrating sensations and performance of ADLs such as sleeping, dressing, eating, engaging in play, and participating in leisure and school-related activities (Chien, Rodger, Copley, Branjerdporn, & Taggart, 2016; Mazurek & Petroski, 2015; Miller Kuhaneck & Britner, 2013).

Although evidence to support specific treatment approaches to address sensory difficulties and their impact on ADLs is emerging, more is needed. The Ayres Sensory Integration® (ASI) intervention, which involves individually tailored sensory–motor activities contextualized in play at the just-right challenge to promote adaptive responses and foster functional skills as a foundation for participation in occupations (Ayres, 2005), is used by more than 95% of occupational therapy practitioners in pediatrics (Mailloux & Smith Roley, 2010). Despite this highly reported use of ASI in clinical practice, confusion exists about the evidence for its effectiveness (Clark, 2012; Schaaf & Case-Smith, 2014).

A previous systematic review by May-Benson and Koomar (2010) examined 27 studies conducted between 1972 and 2007 to investigate the efficacy of the

sensory integration approach. Findings indicated that sensory integration interventions may contribute to improved outcomes in individualized goals; reading and related skills; sensory–motor skills and motor planning; and socialization, behavioral regulation, and attention but that more research is needed, specifically, studies that more closely adhere to the principles of ASI intervention. The authors noted that the review was limited by the fact that many studies did not provide adequate information on whether the intervention adhered to the principles of sensory integration intervention. Only 3 studies measured fidelity or provided manualization of the intervention, and 2 studies implemented the intervention in a way that did not represent ASI principles. An additional factor, identified as affecting interpretation of the existing literature, is the inconsistent and varied use of sensory integration terminology. Many studies (e.g., Lang et al., 2012; Leong, Carter, & Stephenson, 2015; Watling & Hauer, 2015) have reported on interventions claiming to be sensory integration, but these interventions did not adhere to the principles of ASI (Ayres, 1972, 1979, 2005; May-Benson et al., 2014; Parham et al., 2011).

Another confound in the existing literature is that many studies did not complete a thorough assessment to identify the specific sensory–motor factors that may be affecting the individual participants' functioning, thus potentially using a sensory-based intervention for participants who did not demonstrate sensory-based difficulties. The intervention therefore violated a central principle of ASI because it was not tailored to address participants' specific therapeutic needs and was often applied solely on the basis of clinical diagnosis (e.g., ASD or developmental coordination disorder [DCD]). Although many populations such as those with ASD and DCD demonstrate a high incidence of difficulty with processing and integrating sensation (Ben-Sasson et al., 2007; Piek & Dyck, 2004), one cannot assume that these difficulties are ubiquitous or uniform in a population.

A further factor affecting the interpretation of existing literature is that many studies included in past reviews did not use a replicable intervention protocol, and some frequently cited studies included in past reviews specifically violated core principles of ASI intervention, such as child directedness and individually tailored activities (Parham et al., 2007). Without a replicable intervention protocol, the evidence from these studies cannot be substantiated through additional research and clinical practice.

Last, outcome measures used in many previous studies lacked adequate sensitivity to detect changes in key areas purported to be responsive to ASI or did not measure outcomes valued by the client and his or her family (Cohn & Cermak, 1998). These deficiencies have limited the ability to compare and synthesize the results of studies assessing ASI interventions (Case-Smith & Arbesman, 2008; Case-Smith, Weaver, & Fristad, 2014; May-Benson & Koomar, 2010; Watling & Hauer 2015).

Thus, given the limitations of previous reviews, the purpose of this systematic review was to examine the literature on ASI intervention using studies published between 2007 and May 2015 and to specifically focus on evidence that ASI improves functioning and participation in everyday activities for children identified as having difficulties with processing and integrating sensory information. The dependent variables of functioning and participation were identified by the American Occupational Therapy Association (AOTA; 2014) and defined according to World Health Organization (WHO; 2001) terminology. *Functioning,* according to WHO (2001), refers to all body functions, activities, and participation, and *participation* is defined as involvement in a life situation.

Method

This systematic review was completed with support from AOTA as part of its Evidence-Based Practice Project (related reviews include Miller-Kuhaneck & Watling, 2018; Parham & Bodison, 2018; and Pfeiffer, Frolek Clark, & Arbesman, 2018, in this issue). A previous series of systematic reviews covering the 1986–2006 time frame were commissioned by AOTA; these reviews examined interventions for children and adolescents with challenges related to sensory processing and integration. Findings were published in 2010 (May-Benson & Koomar, 2010). The time period for studies reviewed was chosen because it builds on this previous review.

Methodology and search terms for the current review replicated those of the 2010 reviews (see Arbesman & Lieberman, 2010). Additional search terms related to population and types of interventions were added to the previous search terms to ensure maximum coverage for each question (e.g., *clumsy child syndrome; developmental coordination disorder; developmental dyspraxia; fine motor deficits; gross motor deficits; learning disabilities; nonverbal learning disorder; regulatory disorder, sensory integrative dysfunction; sensory modulation disorder; sensory modulation dysfunction; sensory motor deficit; sensory processing disorder; Ayres sensory integration, SI, sensorimotor integration, sensory integration, sensory integrative*). See Supplemental Table 1 (available online at http://otjournal.net; navigate to this article, and click on "Supplemental") for the list of all search terms for this review. A medical

research librarian with experience in completing systematic review searches conducted all searches. Databases and sites searched included MEDLINE, PsycINFO, CINAHL, ERIC, and OTseeker as well as the Cochrane Database of Systematic Reviews. Reference lists from articles included in the systematic reviews were examined for potential articles, and selected journals were hand searched to ensure that all appropriate articles were included.

The inclusion criteria were as follows: (1) Articles appeared in the peer-reviewed scientific literature published in English between 2007 and May 2015; (2) the intervention approach adhered to the principles of ASI (Parham et al., 2011); and (3) participants were children and adolescents with challenges in processing and integrating sensation as documented by assessment of these areas. Data from presentations, conference proceedings, non–peer-reviewed research literature, dissertations, and theses were excluded. Studies of Level I, II, and III evidence were included, with Level IV evidence included if a multiple single-case ABA series was used.

Initial search results for each database were as follows: MEDLINE, 3,255; CINAHL, 2,642; ERIC, 2,465; PsycINFO, 1,319; OTseeker, 1,500; and Cochrane Database, 438, for a total of 11,619 citations and abstracts. Another 9 citations were identified from other sources. Of these, 205 duplicate references from the initial search were removed. The EBP methodology consultant eliminated an additional 11,319 citations as irrelevant on the basis of title and abstract. The remaining 104 abstracts were screened for inclusion criteria by the authors (two doctoral-level occupational therapy university faculty and a doctoral occupational therapy student) of this article, and 82 references were eliminated on the basis of abstracts. Both faculty authors agreed on excluded articles. Full-text versions of 22 potential articles were retrieved and reviewed by the same authors for final inclusion on the basis of the predetermined inclusion and exclusion criteria. Seventeen articles were excluded for reason: 4 articles were not intervention studies, 1 was a Level V case study, 11 did not use ASI intervention, and 1 used ASI intervention but did not select participants by assessing problems with processing and integrating sensations. See Figure 1 for the Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow diagram (Moher, Liberati, Tetzlaff, & Altman, 2009) of the search strategy.

A total of 5 articles met the inclusion criteria and were included in the final review: 3 Level I studies, 1 Level III study, and 1 Level IV study. All articles used children with ASD as the participants. Articles were reviewed for quality (scientific rigor and lack of bias) and level of evidence and were then abstracted using an evidence table summary of methods and findings of the article (Supplemental Table 2, available online). Quality control of the evidence table was provided by the AOTA Evidence-Based Practice Project methodology consultant and staff. Risk of bias for each study was assessed using the methods described by Higgins et al. (2011). Strength of evidence for study outcomes was based on guidelines of the U.S. Preventive Services Task Force (2016):

- *Strong evidence:* consistent results from well-conducted studies, usually at least 2 randomized controlled trials (RCTs)
- *Moderate evidence:* 1 RCT or 2 or more studies with lower levels of evidence with some inconsistency of findings in well-conducted studies also resulting in a designation of moderate evidence
- *Limited evidence:* few studies, flaws in the available studies, and some inconsistency in findings across individual studies
- *Mixed evidence:* inconsistent findings across studies in a given category
- *Insufficient evidence:* number and quality of studies too limited to make any clear classification.

Results

Study Characteristics and Findings

Five studies met the inclusion criteria, including conducting an assessment of participants to ensure they demonstrated difficulty with processing and integrating sensation. All study participants had a diagnosis of ASD, had a mean age of between 4.4 and 4.8 yr (except Pfeiffer, Koenig, Kinnealey, Sheppard, & Henderson's [2011] participants, for whom the mean age was 8.8 yr), and were predominately male. Details for each study are presented in Supplemental Table 2 and summarized in the sections that follow. Inconsistencies in terminology appear across studies, with some researchers referring to ASI as *sensory integration treatment.* For this systematic review, all interventions adhering to Ayres's principles are referred to as *ASI.*

Level I. Dunbar, Carr-Hertel, Lieberman, Perez, and Ricks (2012) reported on a comparative effectiveness RCT comparing ASI with an integrated classroom with sensory activities ($N = 7$; 3 in the treatment group and 4 in the integrated group; mean [*M*] ages = 4.5 yr and 4.4 yr, respectively). One participant was unable to complete the study as a result of illness and was excluded from analysis. The treatment group received occupational therapy using ASI, and although they did not use the ASI Fidelity Measure© (ASIFM), they did describe the core components of ASI. The integrated classroom (control) group also had classroom-based sensory activities. The authors reported

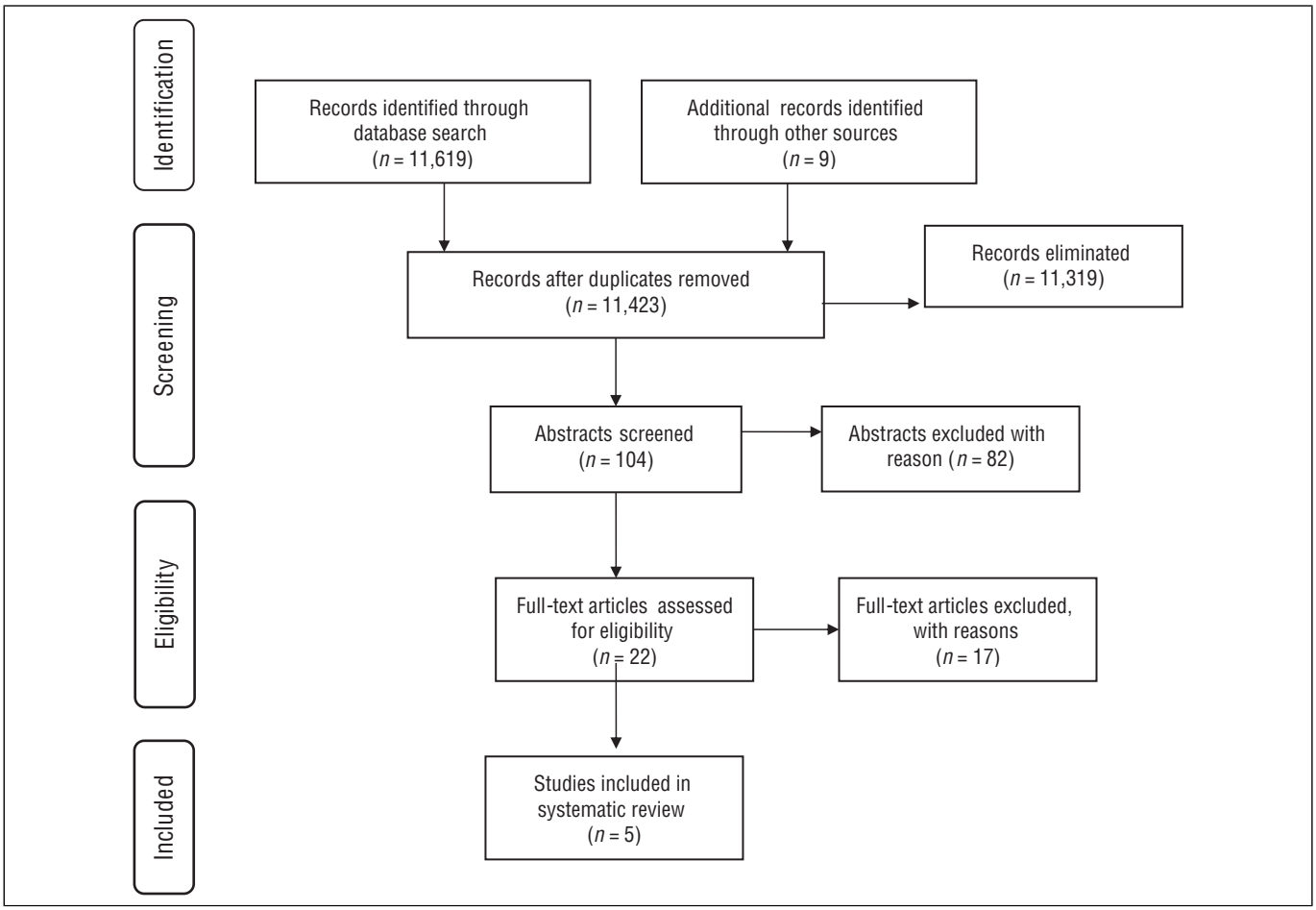

Figure 1. Flow diagram of articles identified, screened, eligible for, and included in the systematic review.

Figure format from "Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement," by D. Moher, A. Liberati, J. Tetzlaff, and D. G. Altman; The PRISMA Group, 2009, PLoS Medicine, 6(6), e1000097. https://doi.org/10.1371/journal.pmed.1000097

that both groups of children improved in play skills as measured with the Revised Knox Preschool Play Scale (Knox, 1997). Although the integrated classroom group had larger gains, this group had higher scores at pretest.

Pfeiffer et al. (2011) conducted a comparative effectiveness RCT with 37 participants (20 in the ASI group, 17 in the fine motor treatment group; *M* age = 8.8 yr). Both treatments were administered by occupational therapists. The fine motor group focused on crafts, drawing, and writing activities, and the ASI group's intervention was consistent with ASI principles and confirmed by use of the ASIFM (Parham et al., 2011). Authors reported significantly higher gains for the ASI group on Goal Attainment Scaling (GAS; Kiresuk & Sherman, 1968; Mailloux et al., 2007) than for the fine motor group; parents $F(1, 34) = 4.87$, $p < .05$, effect size [ES] = 0.125, and teachers $F(1, 30) = 16.92$, $p < .01$, ES = 0.360. Moreover, the ASI group demonstrated significantly decreased autistic behaviors, as measured with the Social Responsiveness Scale (SRS; Constantino & Gruber, 2005; $p < .05$), than the fine motor group. For participants able to complete the Quick Neurological Screening Test, Second Edition (QNST–II; Mutti, Martin, Sterling, & Spalding, 1998) at posttest, the ASI group completed more items of the test from pretest to posttest than the control group.

Schaaf et al. (2014) conducted an RCT with 32 participants (17 in the ASI group, 15 in the control group; *M* age = 4.8 yr). The control group received usual care, and the intervention group received a manualized protocol adhering to ASI principles that was confirmed by use of the ASIFM (Parham et al., 2011). The authors reported significantly higher scores for the ASI group on GAS than the usual-care group, $t(23) = -3.23$, $p = .003$, ES = 1.2. The ASI group required significantly less caregiver assistance with self-care activities and social functioning on the Pediatric Evaluation of Disability Inventory's (PEDI's; Haley, Coster, Ludlow, Haltiwanger, & Andrellos, 1992) Self-Care Caregiver Assistance ($p = .008$) and Social Function Caregiver Assistance ($p = .039$) subscales from pre- to posttest. No significant differences were found on the PEDI in children's social functions or performance of self-care functional skills, although the ASI group's change scores were higher at posttest. Similarly, no significant differences were found in

autism behaviors as measured with the Pervasive Developmental Disorders Behavior Inventory (PDDBI; Cohen, Schmidt-Lackner, Romanczyk, & Sudhalter, 2003), although the ASI group had fewer autism behaviors at posttest.

Level III. Iwanaga et al. (2014) reported on a retrospective analysis of clinical data for 20 participants (8 in the ASI group and 12 in group therapy; *M* age = 4.73 yr and 4.69 yr, respectively) that compared ASI with group therapy. The intervention did not use a manualized approach or a fidelity measure but described the core principles of ASI. The authors reported significant improvement in overall sensory and motor functioning on the Japanese version of the Miller Assessment for Preschoolers (JMAP; Tsuchida, Sato, Yamada, & Matsushita, 1989) Total score for both the ASI ($p = .012$) and the group therapy groups ($p = .015$). The ASI group demonstrated improved functioning on the JMAP Foundation Index (sensory processing and postural skills; $p = .035$), Coordination Index (fine and gross motor skills; $p = .012$), Nonverbal Index (perceptual skills; $p = .018$), and Complex Index (motor planning and sequencing skills; $p = .018$) subscales. In comparison with the group therapy group, the ASI group had greater gains on the Total ($p = .005$), Coordination Index ($p = .008$), Nonverbal Index ($p = .016$), and Complex Index ($p = .034$) scores.

Level IV. Preis and McKenna (2014) reported on a single-subject ABA design study of ASI sessions with 4 participants (*M* age = 4.7 yr). The intervention did not use a manualized approach or a fidelity measure but adhered to the principles of ASI intervention. The authors reported that Child 1 had statistically significant gains in spontaneity ($p = .023$), mean length of utterances ($p = .028$), and engagement ($p = .002$). Child 2 had statistically significant gains only in mean length of utterances ($p = .05$). Child 3 showed the longest mean length of utterance during the ASI condition and the highest scores on engagement post–sensory integration, although these were not statistically significant. Child 4 also had no statistically significant differences, but as with Child 3, his highest mean length of utterance was found in the ASI condition and his highest spontaneity and engagement scores were seen in the post–ASI condition.

Outcome Measures

The studies included in this review used a variety of measures of functioning and participation as well as of underlying factors or impairments influencing these areas. Two of the 3 Level I studies (Pfeiffer et al., 2011; Schaaf et al., 2014) examined parent-identified goals as outcomes using GAS. Goals included areas of functioning and participation that parents believed were important for their child's daily life such as participation in daily routines, mealtime, and learning or social activities (Schaaf et al., 2015). Pfeiffer et al. (2011) also examined some outcomes that measured client factors at the skill or impairment level that support or interfere with participation, such as sensory processing, social skills, autistic behaviors, soft neurological signs, and parental report of adaptive behavior using the Sensory Processing Measure (Parham & Ecker, 2007), the SRS, QNST–II, and the Vineland Adaptive Behavior Scales, Second Edition (Sparrow, Cicchetti, & Balla, 2005).

Schaaf et al. (2014) assessed parent-reported skill performance using the PEDI and severity of autistic behaviors using the PDDBI. Dunbar et al. (2012) evaluated developmental play skills, fine and gross motor skills, and play skills with the Revised Knox Preschool Play Scale. Iwanaga et al. (2014) assessed children's cognitive, verbal, and sensory–motor skills using the JMAP. Last, Preis and McKenna (2014) collected language samples on spontaneity of language, mean length of utterances, and engagement with others pre- and postintervention.

Risk of Bias

The 5 included studies were assessed for their risk of bias according to criteria from Higgins et al. (2011). These data are shown in Table 1. In summary, there was a low risk of random sequence generation bias reported for 2 Level I studies (Pfeiffer et al., 2011; Schaaf et al., 2014) and a low risk of allocation concealment for the Schaaf et al. (2014) Level I study. The risk of bias as a result of a lack of random sequence generation and allocation concealment was mixed and generally unclear across other studies. Performance bias because of lack of blinding of participants was generally unclear, with 2 studies, Dunbar et al. (2012) and Preis and McKenna (2014) not addressing blinding. Schaaf et al. (2014) identified that parents were not blind to the interventions, and Pfeiffer et al. (2011) reported a low risk of bias with blinding of participants and personnel throughout pre- and posttesting. Detection bias because of lack of blinding to outcome assessment was also mixed, with 3 studies (Dunbar et al., 2012; Pfeiffer et al., 2011; Schaaf et al., 2014) reporting low risk of bias and 2 studies (Iwanaga et al., 2014; Preis & McKenna, 2014) reporting a high risk. Outcome data attrition was low across all studies for long-term outcomes. Selective reporting bias was also low across all studies except Preis and McKenna (2014), which was unclear.

Table 1. Risk-of-Bias Table

Citation	Selection Bias		Performance Bias: Blinding of Participants and Personnel	Detection Bias: Blinding to Outcome Assessment	Incomplete Outcome Data (Attrition)		Reporting Bias: Selective Reporting
	Random Sequence Generation	Allocation Concealment			Short Term (2–6 wk)	Long Term (>6 wk)	
Dunbar, Carr-Hertel, Lieberman, Perez, & Ricks (2012)	?	?	?	+	N/A	+	+
Iwanaga et al. (2014)	−	?	−	−	N/A	+	+
Pfeiffer, Koenig, Kinnealey, Sheppard, & Henderson (2011)	+	?	+	+	N/A	+	+
Preis & McKenna (2014)	−	?	?	−	N/A	+	?
Schaaf et al. (2014)	+	+	?	+	N/A	+	+

Note. Categories for risk of bias: + = low risk of bias; ? = unclear risk of bias; − = high risk of bias. N/A = not applicable.
Risk-of-bias table format adapted from "Assessing Risk of Bias in Included Studies," by J. P. T. Higgins, D. G. Altman, and J. A. C. Sterne, in *Cochrane Handbook for Systematic Reviews of Interventions* (Version 5.1.0), by J. P. T. Higgins and S. Green (Eds.), 2011. Retrieved from http://www.cochrane-handbook.org. Copyright © 2011 by The Cochrane Collaboration.

Discussion

This systematic review is unique among reviews of sensory integration intervention (Barton, Reichow, Schnitz, Smith, & Sherlock, 2015; Case-Smith et al., 2014; Lang et al., 2012; Leong et al., 2015; May-Benson & Koomar, 2010; Watling & Hauer, 2015) in that it includes only recent studies that address previously identified concerns of failure to adequately characterize participants' sensory–motor needs, individually tailor the intervention, or use interventions that adequately adhere to core concepts of ASI. More important, all 5 studies included in this review were with participants with autism; selected participants on the basis of evaluation of individual sensory–motor problems, thus justifying the use of ASI; and provided an intervention that adhered to the principles of ASI. Two studies (Pfeiffer et al., 2011; Schaaf et al., 2014) used the ASIFM (Parham et al., 2011) to ensure adherence. The other 3 studies (Dunbar et al., 2012; Iwanaga et al., 2014; Preis & McKenna, 2014) were conducted before the ASIFM was available to the public, but they described adherence to the principles in sufficient detail.

Manualized protocols were used in 2 of the 5 studies (Pfeiffer et al., 2011; Schaaf et al., 2014), allowing for opportunities to replicate these interventions in future research. Thus, there are 2 well-designed intervention studies using ASI with low risk of bias that show positive outcomes, which provides a growing body of evidence supporting the efficacy of the ASI intervention for children with autism in improving outcomes on individualized goals of functioning and participation as measured by GAS.

Many studies were excluded from the review because they lacked adequate description of the intervention tested, and few studies used manualization or fidelity measures. Use of manualized protocols provides opportunities for replication of study protocols and assurance of reliability and generalizability of the interventions and results. A manualized protocol for ASI is now available to guide clinicians and researchers, and future studies can use this protocol to examine this intervention (Schaaf & Mailloux, 2015). Moreover, use of the ASIFM (Parham et al., 2011) in research is important to ensure that researchers adhere to the stated principles of the intervention when developing evidence for ASI in the future.

An important advance in the studies included in this review is the measurement of outcomes that are meaningful to families and that measure change at the functioning and participation levels of the *International Classification of Functioning, Disability and Health* (*ICF;* WHO, 2001). Contemporary practice in rehabilitation research supports the use of outcome instruments that are sensitive to clinically important change and meaningful to clients and their families (Alexander et al., 2009; Jette & Haley, 2005). The Pfeiffer et al. (2011) and Schaaf et al. (2014) studies used GAS, which is a valid and reliable outcome measure for children with autism (Krasny-Pacini, Evans, Sohlberg, & Chevignard, 2016; Ruble, McGrew, & Toland, 2012), is sensitive to family concerns (Mailloux et al., 2007), and measures outcomes that address functioning and participation (Kiresuk, Smith, & Cardillo, 2014). Previous research has shown that parental hopes for their children as a result of ASI intervention revolve around improved self-regulation, social participation, skill performance,

and perceived competence (Cohn, Kramer, Schub, & May-Benson, 2014). In keeping with this trend, the studies included in this review had outcomes in many of these areas.

Previous studies of sensory interventions have focused mainly on skill-based outcomes such as improved sensory processing, motor performance, academic skills, and psychoeducational skills (May-Benson & Koomar, 2010). It is important that the studies in this review not only included these skills-based outcomes but also assessed outcome measures related to participation in daily activities. This approach is consistent with the *ICF* framework (WHO, 2001) and the *Occupational Therapy Practice Framework: Domain and Process* (3rd ed.; AOTA, 2014), as well as with current trends in intervention research (Melnyk & Morrison-Beedy, 2012). Use of outcome measures that address both underlying factors (such as sensory and motor factors) and participation in daily activities allows researchers and clinicians to evaluate the link between these factors and thus evaluate the utility of ASI intervention as it addresses underlying factors as a basis for functioning and participation.

Early in her work, Ayres (1972, 1979, 2005) articulated the importance of considering the sensory–motor factors that may be affecting activities and participation. Her intent was to demonstrate the need to assess sensory–motor foundations of participation in daily activities and to design treatment to address them when appropriate. Studies included in this review embedded these principles of ASI in the interventions while embracing contemporary thinking regarding outcome measurement. They thus provide not only examples for future research but a strong platform for including ASI as part of the occupational therapy domain of practice.

Limitations

This review found much improvement in the quality of intervention research examining ASI intervention compared with previous reviews. Two Level I studies with low risk of bias were identified that provide strong evidence for the use of GAS to measure individualized functional goals in children with ASD (Pfeiffer et al., 2011; Schaaf et al., 2014). However, weaknesses persist that need to be addressed in future research.

Well-designed studies using intervention fidelity, sensitive and meaningful outcome measures, and adequate power are needed to examine the effectiveness of ASI intervention with populations other than children with ASD, including children with learning disabilities, for whom it was designed (Ayres, 1972, 2005), to ensure that the effects of ASI in the studies with children with ASD were not the result of the unique features of ASD. Homogeneous participant samples are needed, and all study participants should be evaluated and selected on the basis of data showing that difficulties processing and integrating sensation may be affecting participation in activities and roles. Moreover, the sample sizes of the included studies are modest, and larger studies are needed. Although financial and time burdens of clinical research often impede the ability to conduct studies using larger sample sizes, it must be a priority.

The inclusion of GAS to measure progress in meaningful areas of concern for the family that are difficult to capture with standardized assessments or that lack individualization in outcome measurement would be beneficial. Additional sensitive and meaningful outcome measures with good reliability and validity for identification of change in short- and long-term follow-up studies and utilization of comparable measures across studies are needed to further build evidence for the effectiveness of ASI intervention. Finally, use of validated outcome measures of client factors combined with outcome measures of functioning and participation such as GAS is recommended to support the ASI approach. The difficulty in synthesizing a body of effectiveness literature in which there is no consistency in outcome measures across studies is a limitation of the current research on ASI. Identification of a consistent battery of outcome measures for use in ASI intervention research would greatly facilitate future research on this intervention.

Implications for Occupational Therapy Practice

Results of this review suggest the following:

- This review supports the use of ASI intervention with children with ASD.
- GAS is a strong, sensitive, and meaningful outcome for ASI intervention.
- The best evidence is for outcomes that focus on areas of functioning and participation that are meaningful to parents and families, which often involves performance or participation in areas such as play, sleep, ADLs, and social participation.
- ASI intervention, whether conducted in research or clinical practice, needs to adhere to intervention fidelity principles.

Conclusion

This systematic review found that the body of evidence supporting ASI intervention with children with ASD is now growing. Strong evidence supports the efficacy of ASI intervention for children with autism in improving outcomes on individualized goals of functioning and participation as

measured by GAS. Moderate evidence was found to support the use of ASI to decrease autistic mannerisms and reduce caregiver assistance for social skills and self-care in children with ASD. Insufficient evidence was found to support changes in outcomes related to play, sensory–motor, perceptual, cognitive, and language skills. Research on ASI intervention has demonstrated increased use of fidelity measures and replicable intervention protocols to meet criteria for evidence-based practice.

These contributions aid in advancing best practice for providing interventions for children with ASD who have sensory processing difficulties and in enhancing participation outcomes. The results of this review underscore the importance of using systematic processes and sensitive and meaningful outcome measures that evaluate children's performance and participation in everyday activities and routines. Continued research with additional populations should involve manualized intervention protocols to substantiate evidence of the efficacy of ASI intervention for persons not represented in this review. ▲

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