Introduction to the Evaluation in Ayres Sensory Integration ® (EASI)

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Introduction to the Evaluation in Ayres Sensory Integration® (EASI)

Zoe Mailloux, L. Diane Parham, Susanne Smith Roley, Laura Ruzzano, Roseann C. Schaaf

Comprehensive, reliable, and valid assessment is essential for individually tailored, appropriate, and effective intervention planning and implementation. Research, education, and practice using an Ayres Sensory Integration® (ASI) approach have a long history of prioritizing comprehensive assessment. To meet the need for a set of tests that will fully evaluate the constructs of ASI with psychometrically strong, internationally appropriate, and easily accessible measurement tools, the development of the Evaluation in Ayres Sensory Integration® (EASI) has been initiated. This article introduces the EASI, describes the overarching plan for its development, and reports the results of promising preliminary analyses of discriminative validity data.

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A comprehensive evaluation of the sensory, motor, and praxis functions that can influence occupational performance is critical to evidence-based intervention. A research-informed and thorough assessment process allows for adequate characterization of a person's strengths and challenges to plan appropriate and individually tailored interventions.

Reliable and valid assessment tools, especially those standardized for specific populations, provide objective and credible procedures for measurement of the sensory integration (SI) functions that may underlie participation and occupation. Systematic use of assessment data to plan intervention can increase the likelihood that services are provided in a cost-effective, efficient, and effective manner to achieve optimal outcomes.

Early in her professional career, A. Jean Ayres recognized the importance of systematic and comprehensive assessment, as evidenced by her seminal work in the measurement of sensory, motor, and praxis function and dysfunction. To understand sensory integration as it related to successful participation in play, self-care, and schoolwork activities, she designed and adapted standardized tests that evaluated the constructs of SI. These constructs included sensory perception, praxis, bilateral integration, and balance, as well as nonstandardized observational measures of functions such as sensory reactivity and postural mechanisms (e.g., the ability to assume and maintain a prone extension or supine flexion posture; Ayres, 1971).

Ayres developed individual tests and then published the Southern California Sensory Integration Tests (SCSIT; Ayres, 1972a), which were later revised and restandardized to become the Sensory Integration and Praxis Tests (SIPT; Ayres, 1989). The SIPT, standardized on approximately 2,000 children ages 4 yr through 8 yr 11 mo, is the only published set of tests that collectively addresses most of the core SI functions identified by Ayres. The SIPT demonstrates strong reliability and validity (Ayres, 1989) and has been the gold standard for assessment of sensory integrative functions in children.

Ayres used the SCSIT, and later the SIPT, in research with both typically developing children and children with learning and behavioral difficulties to identify key SI constructs and to gain insight into how SI functions are related to occupational performance. This body of research (Ayres, 1965, 1966a, 1966b, 1969, 1971, 1972b, 1977, 1989) and her extensive clinical experience provided the knowledge base for the development of Ayres Sensory Integration® (ASI) theory and practice (Smith Roley, Mailloux, Miller-Kuhaneck, & Glennon, 2007). ASI assessment and intervention together are designed to improve the client factors that are affecting participation in daily occupations.

The SIPT, although an excellent set of tests, has limitations. The normative data for the SIPT were collected in 1984–1985. The dramatic surge in use of digital technologies over the past 30 yr has contributed to changes in human activity patterns, and so the original normative data may be different from contemporary norms. Accessibility and use of the SIPT are limited because of the cost of SIPT kits (including shipping), the cost of required computer scoring technology, and lack of translated materials and validated use of the SIPT outside the United States. The lack of availability of normative data for populations outside the United States is an increasing concern as growing numbers of occupational therapy practitioners across the globe become educated in sensory integration so that they can provide high-quality assessment in ASI.

To meet the need for a set of tests that evaluate the constructs of ASI with psychometrically strong, internationally appropriate, and easily accessible measurement tools, the development of the Evaluation in Ayres Sensory Integration (EASI) was initiated. The purpose of this article is to introduce the EASI and report findings from preliminary test analyses.

Overview of EASI Development

The purposes of the EASI are twofold: (1) to provide an inexpensive, electronically accessible, and practical instrument for clinical evaluation of SI and related functions in children ages 3–12 yr and (2) to ensure that the scores provided by this instrument are reliable, valid, and relevant for the international populations being served. The process of developing the EASI has followed well-established guidelines for test development from feasibility to psychometrics (e.g., Benson & Clark, 1982; Crocker & Algina, 1986). Specifically, the process for development of the EASI is following the series of steps shown in Figure 1, including establishment of the overarching aims and constructs of the EASI, feasibility testing, pilot testing, normative data collection, and publication and dissemination of the tests. In this article, we describe Steps 1 and 2, which have been completed.

Step 1: Aims and Constructs of the EASI

The purpose of the EASI is to enable occupational therapy practitioners across the globe to conduct comprehensive,

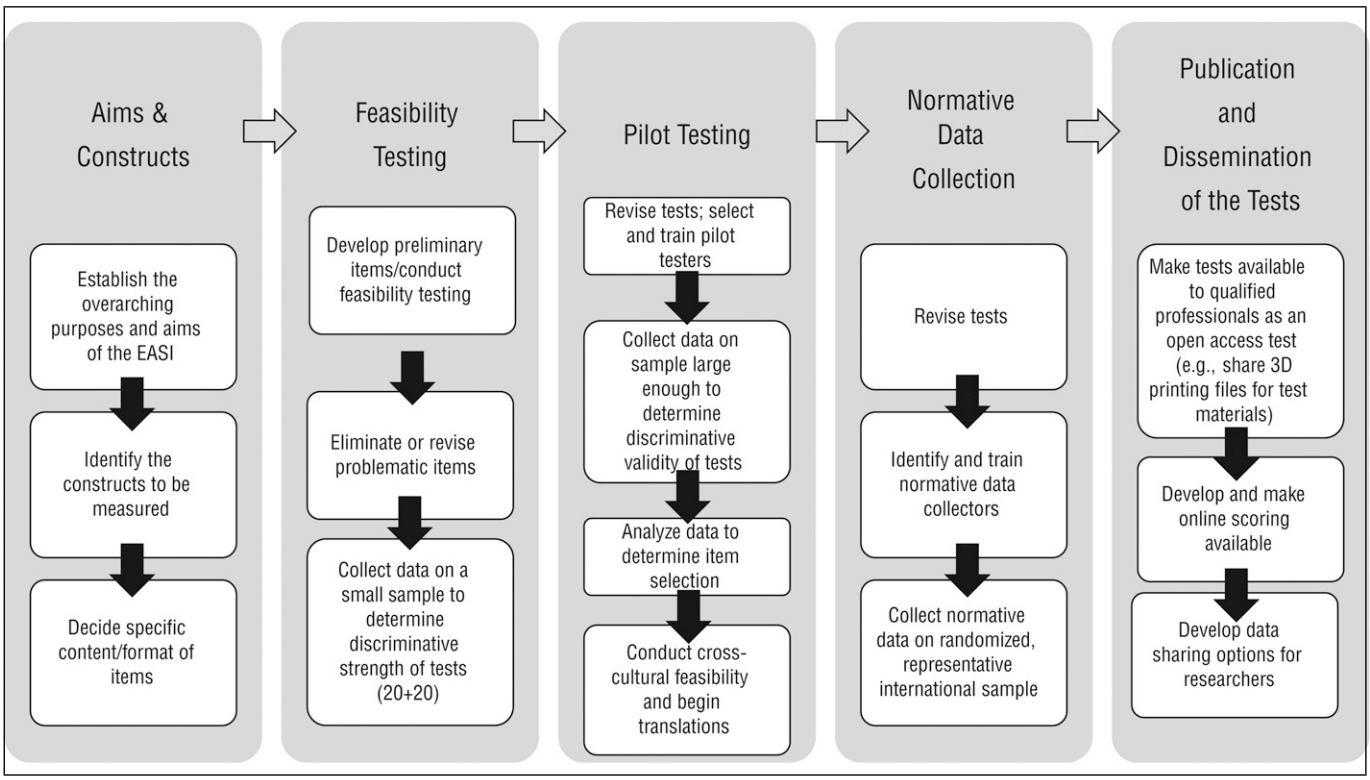

Figure 1. Steps in the development of the Evaluation in Ayres Sensory Integration® (EASI).

rigorous evaluation of SI for children so that precise and focused therapy can be provided. The specific aims of the EASI are that the tests will be aligned with major constructs in ASI theory; easily accessible, reliable, and valid; and standardized and norm referenced for optimal use in geographically diverse locations.

Open access to these tests will make high-quality assessment and intervention in ASI widely accessible. By *open access,* we mean that appropriately credentialed and trained users will have free, unrestricted access to downloadable links for materials needed to administer and score the tests (e.g., test manuals, test forms and scoring test sheets, 3D printed objects such as shapes used for tactile perception tests, online processes for conversion of raw scores to standard scores). Other test materials will be inexpensive items that users can purchase locally (e.g., cotton balls, cloth napkins, therapy balls, yoga mats). The accessibility of the EASI, along with its rigor as a reliable and valid tool and provision of geographically specific normative data, will strengthen the ability of occupational therapy practitioners to conduct a systematic assessment of SI and provide individually tailored ASI intervention within their own countries. In addition, the process for the development of the EASI may also serve as a model for development of measures and international norms needed in other areas of occupational therapy practice.

Constructs measured by the EASI are drawn from ASI theory and practice. Our selection of constructs was influenced by the many studies of SI and related functions conducted originally by Ayres beginning in the 1960s (Ayres, 1965, 1966a, 1966b, 1969, 1971, 1972b, 1977, 1989) and more recently by others (Mailloux et al., 2011; Mulligan, 1998, 2000, 2011; Van Jaarsveld, Mailloux, Smith Roley, & Raubenheimer, 2015). The sum of these studies indicates that four distinctive patterns of sensory integrative function and dysfunction exist: (1) sensory perception in tactile, proprioceptive, vestibular, and visual systems; (2) praxis based on somatosensory, language, and visual-based functions; (3) postural, ocular, and bilateral integration based on vestibular functions; and (4) sensory over- and under-reactivity (Mailloux et al., 2011; the core constructs are defined and discussed in detail in Schaaf & Mailloux, 2015).

Twenty-one different tests (one with three parts), as shown in Table 1, have been designed to measure these four overarching sensory integration constructs in four domains: (1) Sensory Perception; (2) Praxis; (3) Ocular, Postural, and Bilateral Motor Integration; and (4) Sensory Reactivity. The first three authors of this article (Mailloux, Parham, and Smith Roley) conducted the initial process of item construction. Because the EASI aims to assess children ages 3–12 yr, each test is designed to contain items with a wide range of difficulty levels, from very easy tasks for the youngest age groups to much more complex tasks for the oldest age groups.

To address the aim of making the EASI an open-access test, the required test materials must be either common objects or materials that are readily available internationally (e.g., pipe cleaners or chenille craft sticks) or items that can be 3D printed. Verification of material availability worldwide was accomplished through social media responses from more than 100 countries. The feasibility of consistency in 3D printing has since also been verified in several countries.

Table 1. Tests in the Evaluation in Ayres Sensory Integration® (EASI)

Category	Tests
Sensory Perception tests	Tactile Perception
	Localization (TP:L)
	Designs (TP:D)
	Shapes (TP:S; 3 parts: TP: S1, TP:S2 and TP:S Oral
	Textures (TP:T)
	Proprioception
	Joint Positions (Prop:JP)
	Force (Prop:F)
	Vestibular Function
	Ocular Reflex (V:OR)
	Visual Perception
	Orientation (VP:O)
	Search (VP:S)
	Auditory Function
	Localization (A:L)
Praxis tests	Somatosensory-Based Praxis
	Positions (Pr:P)
	Sequences (Pr:S)
	Visual-Based Praxis
	Tracing (VPr:T)
	Designs (VPr:D)
	Construction (VPr:C)
	Language-Based Praxis
	Following Directions (Pr:FD)
	Ideation-Based Praxis
	Ideation (Pr:I)
Ocular, Postural, and Bilateral Motor Integration tests	Ocular Motor and Praxis (O:MP)
	Postural Control and Balance (PCB)
	Bilateral Integration (BI)
Sensory Reactivity items and tests	Tactile
	Defensiveness (TD)
	Tactile Registration Problems (TRP)
	Auditory
	Defensiveness (AD)
	Auditory Registration Problems (ARP)
	Olfactory
	Defensiveness (OD)
	Olfactory Registration Problems (ORP)
	Vestibular
	Motion Defensiveness (MD) and Motion Registration Problems (MRP)
	Gravitational Insecurity (GI)

Step 2: Feasibility Testing

Feasibility and pilot testing was conducted using U.S. samples because it seemed prudent to ensure that the tests could be administered and scored in a feasible manner and that materials were manageable before collecting international normative data. In addition, the university internal review board that reviewed and approved these studies did not allow data collection outside the United States. Moreover, conducting the initial studies in the United States would provide needed data for shortening the test, thus reducing the amount of translation and test materials that would be required for international samples.

A group of approximately 15 occupational therapists, 5 of whom trained and worked with Ayres during the development of the SIPT, conducted the feasibility testing. Two occupational therapists acted as the feasibility project coordinators. Feasibility testing included the development and trying out of test sheets and forms, verbal directions, materials management, administration techniques, and scoring procedures. Revisions were made on the basis of feedback from the group.

Feasibility testing culminated in a preliminary analysis to determine discriminative validity of the tests. This aspect of feasibility testing was called a "20 + 20" project with a plan to test two children at each age year (3 yr through 12 yr, making 10 age groups) from both typically developing (TYP) and SI concerns (SI) groups on each of the tests, yielding 20 participants in each group. Results of the 20 + 20 projects are reported in the Results section. After data analyses, some items were eliminated and others revised. In addition, feedback from feasibility testers about the logistics and ease of administration and scoring led to some alterations in test procedures, materials, and scoring, in preparation for pilot testing.

Method

Participants

The feasibility project coordinators and testers recruited children through their contacts and clinical practices. The children ranged in age from 3 to 12 yr and were selected on the basis of the inclusion and exclusion criteria for the project (see Table 2). The children were also closely matched on age and ratio of boys to girls. For convenience, all children were selected from communities in Southern California. Ethnicity and socioeconomic status were not tracked for this phase of test development. The EASI tests were divided into four sets, and a separate 20 + 20 project was conducted for each set. The 20 + 20 data collection and analyses have been completed on the first three sets of tests, and the fourth is in process. This grouping process resulted in a new sample of children for each set of tests; therefore, sample characteristics are shown for each grouping in Table 3.

Procedures

Before the 20 + 20 data collection, the tests were administered to a few children of various ages by the feasibility project coordinators. Approximately 15–20 feasibility testers, including the feasibility project coordinators, who were licensed occupational therapists with advanced training in sensory integration, prepared for test administration by reviewing and discussing administration and scoring instructions. The testers communicated frequently to review and clarify the testing procedures. For each set of tests, the test administration process took 2–6 mo.

Table 2. Participant Inclusion and Exclusion Criteria

Criteria Type	Typically Developing Children	Children With Known or Suspected Sensory Integration Concerns
Inclusion	Children ages 3 yr 0 mo to 12 yr 11 mo who are generally considered to be developing and performing within age expectations and who have no known medical, educational, mental health, or other developmental concerns	Children with known or suspected problems in learning or behavior who have been identified as having sensory integration concerns by a sensory integration–trained occupational therapist, physical therapist, or speech–language pathologist. Children with diagnoses such as learning disorders, autism, attention deficit disorder, speech and language delays, problems with anxiety, regulatory issues, hypotonia as a standalone diagnosis, and developmental coordination disorder may be included as long as they have also been identified as having some sensory integration concerns and do not meet exclusion criteria. Children with known or suspected problems with sensory integration are the highest priority for inclusion.
Exclusion	Children with any known medical, educational, mental health, or other developmental concerns and children about whom there are any suspected problems in sensory integration, including those who have been referred for or who have received therapy for sensory integration concerns	Children who have physical disabilities (e.g., cerebral palsy, spina bifida, spinal cord injury), significant cognitive deficits (i.e., IQ <70 or diagnosis of a developmental delay or cognitive disability), visual or hearing impairments, or other conditions that include as symptoms sensory or motor impairments and children for whom English is not a primary language. Children who have not been identified as having sensory integration concerns should also be excluded.

Table 3. Preliminary Results for Discriminative Validity

EASI Test	Sample Size		Male: Female Ratio		Age, yr, *M* (*SD*)		Accuracy Scores, *M* (*SD*)		Group Comparison Results
	SI	TYP	SI	TYP	SI	TYP	SI	TYP	
Tactile Perception tests	21	20	16:5	15:5	7.8 (2.5)	7.8 (2.9)			
Localization							34.6 (8.5)	42.8 (5.6)	$t(26) = -3.4$, $p < .01$*
Designs[a]							29.5 (15.5)	46.7 (13.9)	$t(34) = -3.6$, $p < .001$*
Textures							7.4 (2.5)	8.8 (1)	$t(22) = -2.2$, $p < .05$*
Shapes: Part 1							10.4 (3.2)	11.9 (2.1)	$t(31) = 1.8$, $p > .05$
Shapes: Part 2							10.9 (3.1)	12.1 (2.7)	$t(27) = -1.2$, $p > .05$
Shapes: Oral							3.9 (3.2)	5.5 (3)	$t(36) = -1.6$, $p > .05$
Proprioception tests	16	16	9:7	10:6	6.5(2.3)	7.6(3.0)			
Force							70.9 (35.5)	62.1 (34.9)	$t(25) = -0.7$, $p > .05$
Joint Positions[b]							NA	NA	NA
Vestibular: Ocular Reflex[c]									
Praxis tests	19	19	13:6	13:6	6.9 (2.7)	7.9 (2.7)			
Positions							55.9 (18.9)	74.7 (17.4)	$t(32) = -3.2$, $p < .01$*
Sequences							42.9 (20.2)	63.8 (14)	$t(24) = -3.4$, $p < .01$*
Following Directions							55 (22.4)	70.8 (10.1)	$t(21) = -2.7$, $p < .01$*
Ideation[b]							NA	NA	NA
Ocular, Postural, and Bilateral Motor tests	16	16	9:7	10:6	6.5(2.3)	7.6(3.0)			
Bilateral Integration							20.2 (9.2)	29.5 (7.4)	$t(21) = 2.8$, $p < .01$*
Ocular Motor and Praxis							40.1 (26.7)	69.1 (30.9)	$t(28) = -2.8$, $p < .001$*
Postural Control and Balance[b]							NA	NA	NA

Note. *M* = mean; NA = not analyzed; *SD* = standard deviation; SI = sample of children with known or suspected sensory integration concerns; TYP = sample of typically developing children.
[a]Designs was initially scored as 0 or 1; however, after discussion and analysis, scoring was modified to 0, 1, or 2. Results reflect the modified scoring method. [b]These three tests were not statistically analyzed because of a need to improve the scoring methods. [c]Vestibular: Ocular Reflex was not administered because this test measures a reflex that has consistently been shown to be highly discriminative (Ayres, 1989).
*$\alpha \leq .05$.

Data Analysis

Field testing and 20 + 20 projects were completed on 14 tests (1 with 3 parts) in this analysis. For each test included in this analysis, participant characteristics and independent samples *t* tests were compared to determine similarity of the TYP and SI groups, and independent samples *t* tests were used to compare total performance scores between the groups. Before the performance comparison, some items were omitted because of difficulty level (too easy or too difficult for most ages), discrepancies in scoring across examiners, or other difficulties in administration or scoring.

Results

Results are shown in Table 3. All tests analyzed thus far, except for Tactile Perception: Shapes and Proprioception: Force, yielded significantly higher scores among the TYP group than the SI group, suggesting that the tests are trending toward discriminating between the two samples of children. For those tests that did not discriminate between groups (i.e., Tactile Perception: Shapes and Proprioception: Force), we deliberated among the feasibility testers on test characteristics such as feasibility of administration, scoring methods, and other options for measurement of the specific SI construct. On the basis of this deliberation, we made adjustments to the tests in preparation for the pilot phase. For example, we eliminated some too-easy or too-difficult items, added greater specificity in scoring, and generated new items.

Additional scores (e.g., time scores, sensory reactivity scores) and other factors (e.g., age effects, item analyses) were not statistically analyzed during the 20 + 20 projects, given the small sample size and purpose of this phase of test development. However, we visually analyzed data for trends. Consistently across tests and groups, the youngest children showed distinctly lower accuracy scores than the older children. Sensory reactivity to tactile test items appeared higher among children in the SI group compared with the TYP group. In addition, the amount of time the children took in making choices (time scores) appeared to be an important distinguishing factor between groups and will be further assessed in the pilot study and in future phases of test development.

Discussion

The EASI is still at an early phase in the test development process; however, on the basis of results from the feasibility testing, its usefulness appears promising. All tests analyzed to date, except for Tactile Perception: Shapes and Proprioception: Force, were found to differentiate the TYP and SI groups, even in these relatively small feasibility samples. Those two tests were revised on the basis of the feasibility results before pilot testing. The pilot testing will be used to determine whether the revised tests demonstrate discriminative validity before we finalize the tests for international normative data collection.

Although we chose the age range of 3–12 yr to cover as wide a range of needs as possible, it is likely that some items or tests will be too easy or too difficult for the end age ranges. On the SIPT, several aspects of the tests (e.g., Constructional Praxis Part 2, Manual Form Perception Part 2, Sequencing Praxis Finger Items) are not administered to 4-yr-olds because these aspects did not demonstrate discriminative validity at a sufficient level. The wider scale pilot testing and eventual normative data collection on the EASI will allow for item selection, as well as basal and ceiling levels by age, to ensure that only necessary and meaningful items remain in the final version of the tests.

The development of the EASI, through grassroots, volunteer efforts and fueled by social media resources, potentially provides a new model for test construction in fields such as occupational therapy and other health and education services, which face ongoing financial support challenges. The open-access nature of the EASI also holds potential for ongoing test development and refinement. With the possibility of a worldwide shared data repository, administration, scoring, and interpretation of the EASI will be open to continual improvement and expansion.

Implications for Occupational Therapy Practice

Tailored interventions use person-specific characteristics to design treatment that is specialized to an individual or a group to improve health or change behavior (Gitlin et al., 2009; Schaaf, 2015). As such, tailoring is akin to the process used to target treatments in precision medicine. *Precision medicine* is an emerging approach for disease treatment and prevention that considers individual variability in genes, environment, and lifestyle for each person (National Institutes of Health, 2017).

In occupational therapy, precision therapy can be viewed as an approach that considers the individual's unique characteristics in relation to culture, family characteristics, environmental supports and barriers, needs, and goals when planning interventions (Schaaf, 2015). The application of precision therapy in occupational therapy for children aims to increase the likelihood that intervention will directly address specific needs, priorities, and environments, thus increasing the potential for meaningful and favorable outcomes.

The results of this research have the following implications for occupational therapy practice:

- When the presenting problems suggest that a child's participation difficulties may be related to sensory or motor difficulties, a comprehensive assessment of sensory integration is necessary to obtain the data needed to design precision therapy (Schaaf & Mailloux, 2015).
- An appropriate and comprehensive assessment, which includes the way in which a person processes and integrates information from his or her body and the environment and uses it to plan and organize actions, ensures that services provided center on the life situation of the individual being served with consideration of personal characteristics, lifestyle, family priorities, context, and culture.
- The EASI is being developed to provide occupational therapy practitioners who serve clients with SI needs an appropriate and comprehensive assessment to ensure that appropriate and effective intervention can be planned and implemented. ▲

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