Autism Observation Scale for Infants

Susan E. Bryson and Lonnie Zwaigenbaum

Introduction

The Autism Observation Scale for Infants (AOSI; Bryson et al. 2000) was developed for research purposes, specifically, to address the need for a systematic method of detecting and monitoring signs of autism in high-risk infants with an older sibling with some form of autism (hereafter, "high-risk infant siblings"; see Zwaigenbaum et al. 2005, for details on our large, multisite study of high-risk infant siblings). Since its original conception over 10 years ago, the AOSI has been adopted by several teams engaged in related research in the USA and abroad. In this chapter, our goals are threefold: first, to describe the AOSI and its development; secondly, to provide an overview of research using the AOSI; and, finally, to summarize current data on the predictive validity of the AOSI. We emphasize from the outset that published data on the AOSI come from high-risk infant siblings ("HR infants"), about 20 % of whom are diagnosed with Autism Spectrum Disorder (ASD) by 3 years of age (Ozonoff et al. 2011). Our published data indicate that behavioral risk markers measured by the AOSI differentiate HR infants subsequently diagnosed with ASD from other HR infants, as well as low-risk (LR) comparison infants without a family history of ASD (Brian et al. 2008; Zwaigenbaum et al. 2005). However, it remains unknown whether the findings from this research can be generalized to the detection of early signs of ASD outside of this specific high-risk context. This, together with several other considerations, signals the need for caution in using the AOSI for clinical rather than research purposes, a matter to which we return later.

S.E. Bryson (✉)
Autism Research Centre, IWK Health Centre, Halifax, NS, Canada
e-mail: susan.bryson@iwk.nshealth.ca; helen.cullen@iwk.nshealth.ca

L. Zwaigenbaum
Autism Research Centre, Glenrose Rehabilitation Hospital, Edmonton, AB, Canada
e-mail: lonnie.zwaigenbaum@albertahealthservices.ca; annette.specht@albertahealthservices.ca

V.B. Patel et al. (eds.), *Comprehensive Guide to Autism*,
DOI 10.1007/978-1-4614-4788-7_12,

The AOSI and Its Development

A detailed description of the Autism Observation Scale for Infants (AOSI) and its development is provided in Bryson et al. (2008). Briefly, the AOSI is a 19-item direct observational measure designed to detect and monitor signs of autism in infants aged 6–18 months. This is accomplished through a standard set of semi-structured activities, administered by an examiner who is both skilled at interacting with infants and knowledgeable about ASD. The activities provide an interactive context in which the examiner engages the infant in play while conducting a set of systematic presses to elicit particular target behaviors. The presence/absence and nature of these "pressed for" behaviors is rated by the examiner, as is an additional set of behaviors, which the examiner targets for observation throughout the entire assessment. The AOSI takes about 20 min to administer and is conducted at a small table, with the infant seated on his/her parent's lap, across from and facing the examiner. Parents are encouraged to assist in making the infant comfortable but otherwise to assume an observer role.

The development of the AOSI involved four steps: (1) identification of the behaviors to be targeted for assessment, (2) development of activities appropriate to eliciting and assessing the target behaviors, (3) operationalization of the target behaviors and their associated ratings, and (4) revision and refinement of the instrument through pilot testing.

Target behaviors were drawn from available data on the earliest signs of autism, as derived from parents' retrospective reports (e.g., Gillberg et al. 1990), early home videotapes (e.g., Adrien et al. 1992), and case studies of children later diagnosed with autism (Dawson et al. 2000; Sheinkopf et al. 2000) and from our collective clinical experience with toddlers with ASD. These behaviors include visual tracking and attentional disengagement, coordination of eye gaze and action, imitation, early social-affective and communicative behaviors, behavioral reactivity, and various sensory-motor behaviors (see Table 1). Following pilot testing, items related to two behaviors (cuddliness and soothability) were eliminated because there was often insufficient opportunity to observe these target behaviors; at the same point in time, we added three new items (engagement of attention, shared interest, and insistence on having particular objects or activities), thus changing the original 18 items to 19.

Administration and Coding of AOSI Target Behaviors

Target behaviors are assessed within a standard set of activities, in which the infant is engaged by using various toys (several rattles, a bell, blocks, a book, soft balls, a rubber duck, a plastic stick, and a blanket), and systematic presses are designed to elicit particular target behaviors (visual tracking, disengagement of attention, orientation to name, reciprocal social smiling, differential response to facial emotion, social anticipation, and imitation). To provide examples, in the case of visual tracking, the infant's attention is engaged by shaking a rattle at midline; the rattle is

Table 1 Description of the behaviors assessed in the AOSI

Item	Behavior assessed
1. Visual tracking	Ability to visually follow a moving object laterally across the midline
2. Disengagement of attention	Ability to disengage and move eyes/attention from one of two competing visual stimuli
3. Orientation to name	Ability to move head and/or eyes toward and look at the examiner when name is called
4. Differential response to facial emotion	Ability to respond differentially through facial, head, or other motor movements to a change in the examiner's facial expression from smiling to a neutral expression
5. Anticipatory social response	Ability to anticipate and enjoy social (vs. physical) cause-effect relationships
6. Imitation	Ability to reproduce an action produced by the examiner
7. Social babbling	Ability to engage in back-and-forth (reciprocal) vocalizations with the examiner
8. Eye contact	Ability to consistently establish appropriately sustained eye contact with the examiner
9. Reciprocal social smile	Ability to smile in response to the examiner's smile
10. Coordination of eye gaze and action	Ability to coordinate gaze with actions on objects
11. Behavioral reactivity	General responsiveness, including under reactivity and over reactivity, to the activities and toys introduced, and to the examiner's actions
12. Social interest and shared affect	Ease of engagement and interest in activities and ability to share positive affect with the examiner
13. Transitions	Ease and consistency with which toys are relinquished and movement is made from one activity to another
14. Motor control	Degree to which motor behavior is goal directed, organized, and modulated
15. Atypical motor behavior	Presence of developmentally atypical gait, locomotion, motor mannerisms/postures, or repetitive motor behaviors
16. Atypical sensory behavior	Presence of developmentally atypical sensory behaviors in any modality (e.g., smelling of toys, staring at hands/shapes/objects, or feeling textures)
17. Engagement of attention	Ability to engage or focus attention and eyes on a range of objects or events in the environment
18. Insistence on specific objects/activities	Presence of repetitive interests or behaviors
19. Sharing interest	Uses eyes to reference and share interest in an object or event with another person

Adapted from Table 1 in Bryson et al. (2008)

then positioned to one side of the infant, and his/her ability to laterally track the rattle is assessed as the rattle is moved silently at eye level across the midline from one side to the other. For disengagement of attention, a rattle is shaken to one side of the infant, and, once his/her attention is engaged, a second rattle is shaken on the opposite side, and the infant's ability to disengage and move his/her eyes/attention

from the first to the second rattle is assessed. Reciprocal social smiling is assessed by observing whether the infant smiles in response to the examiner's smile. For differential response to facial emotion, the examiner establishes eye contact with the infant, and the infant's facial expression, head, or other motor movements are assessed in response to a change in the examiner's facial expression from smiling to a neutral/blank expression. In the case of social anticipation, the infant is engaged in a game of peek-a-boo, and when the examiner is hidden behind a blanket (or her hands), preparing to say "peek-a-boo," the infant's ability to anticipate seeing the examiner's face is assessed. For orientation to name, the examiner moves away from and to one side of the infant and, while the infant is looking elsewhere, assesses whether the infant will orient to, and look at, the examiner when his/her name is called. For the imitation item, the examiner assesses the infant's ability to reproduce either an oral-facial movement (tongue protrusion or round mouth movement for 6–11-month-olds) or an action with an object (e.g., patting a ball or tapping the table with a plastic stick) for 12–18-month-olds.

Each press is administered a predetermined number of times (details provided in an accompanying manual), and trials are repeated if the infant is distracted or is otherwise inattentive to the task at hand. The assessment typically begins with the presses for visual tracking and attentional disengagement, although task order is flexible and dependent on the interests of the infant. Presses for reciprocal social smiling, orientation to name, and differential response to facial emotion are interspersed between other structured activities, as are two free play sessions, during which the examiner engages the infant in rolling a ball back and forth, playing with blocks and looking at a picture book, all designed to optimize the infant's comfort and create opportunities for social babbling. Observations of the remaining target behaviors (social babbling, eye contact, gaze-action coordination, reactivity, social interest and affect, transitions, motor control, atypical motor behavior, atypical sensory behavior, engagement of attention, insistence on having particular objects or activities, and sharing interest) are made throughout the entire interactive play assessment.

Target behaviors have been operationalized and, with three exceptions (eye contact, atypical motor behavior, and atypical sensory behavior), are rated on a scale from 0 to 2 or 3, where 0 implies typical function and scores of 1 to 3 represent increasing severity of impairment. Eye contact and atypical motor and sensory behavior are rated on a scale that is confined to 0 (typical) and 2 (atypical). In general, 0 represents typical behavior; 1 represents inconsistent, partial, or questionable behavior; 2 represents atypical behavior; and 3 represents a total lack of the behavior or extremely atypical behavior. In the case of visual tracking, for example, a score of 0 represents the ability to smoothly track a silent object moved laterally across the midline on 2 presses/trials, a score of 1 implies delayed or interrupted eye movements (i.e., in the absence of any external event, infant looks away and then returns gaze to object or does not cross midline), a score of 2 implies partial visual tracking or tracking of noisy objects alone, and a score of 3 implies that the infant does not track objects laterally (but may track vertically). For social interest and shared affect, which is assessed throughout the AOSI, a score of 0 represents sustained interest and pleasure directed at the examiner; a score of 1

implies inconsistent interest and/or little, if any, pleasure; a score of 2 implies interest or pleasure only in response to self-directed actions or to toys or physical events such as tickling; and a score of 3 implies that the infant shows no interest or pleasure. Similarly, for transitions, which codes for the ease and consistency with which the infant relinquishes toys and moves from one activity to another, a score of 0 represents no difficulty, a score of 1 implies some resistance but can be redirected with no distress, and a score of 2 implies repeated and marked difficulty with distress or disruption to the assessment. Item content (except for the imitation item, as described above) and the criteria for rating target behaviors (except for motor control, which takes account of the child's age) are the same for infants ranging from 6 to 18 months, with an emphasis on the quality and consistency of behaviors to help ensure that all items can be meaningfully coded across this age range.

Over a period of more than 2 years, the scale was revised and refined through piloting various methods of eliciting and rating the behaviors in low-risk and various high-risk infants (notably, premature infants, those with infantile spasms and those with an older sibling with ASD) aged 6–18 months. Currently, the AOSI serves as a research instrument, and in that capacity, its purpose is to both detect and monitor the earliest signs of autism and to yield a better understanding of their nature and relationship to other, as yet unidentified, early developmental features of the disorder. Below we provide an overview of research using the AOSI. We begin by outlining the methods used to assess inter-rater and test-retest reliability of the AOSI and provide initial data on both.

Inter-rater and Test-Retest Reliability of the AOSI

In one of our earliest studies (Bryson et al. 2008), we examined the inter-rater and test-retest reliability of the AOSI. For the purpose of assessing inter-rater reliability, 32 HR infants (15 males) were seen at 6 months of age (M = 6.7 mos; SD = 12.2 days; range = 6.1–7.3 mos), 34 (19 males) at 12 months of age (M = 12.5 mos; SD = 10.6 days; range = 12.0–12.8 mos), and 26 (10 males) at 18 months of age (M = 18.9 mos; SD = 11.8 days; range = 18.0–19.1mos). Most of the infants (approximately 60 %) were seen at each age. Of the 34 HR infants seen at 12 months of age, 11 returned for a follow-up visit, 2 weeks after the 12-month visit, to assess test-retest reliability of the AOSI; an additional 9 new cases (i.e., infants not assessed for inter-rater reliability, also seen 2 weeks after their 12-month study visit), were included, for a total of 20 infants (10 males; M = 12 mos). The examiner who conducted the second assessment was blind to the infant's previous AOSI results. All children were seen at the Autism Research Unit at The Hospital for Sick Children in Toronto or the Autism Research Centre at the IWK Health Centre in Halifax. Written informed consent was obtained from parents of the infant participants prior to any assessments.

For each infant at each age, we compared the scores of two raters (the examiner and an independent rater who was present in the room during the assessment) on each AOSI item and on the total number of items endorsed ("total marker count,"

out of a possible 18; recodes scores of 1 and higher as 1, treating AOSI items as behavioral markers that are either present or absent) and total scores (out of a possible 50). The overall inter-rater reliability of AOSI total marker counts and total scores, respectively, was excellent at 6 (.68 and.74), 12 (.92 and.93) and 18 months (.93 and.94). Reliability of individual items both for binary scores and 0–2/3 ratings, each assessed using unweighted kappas, was generally good to excellent (i.e., >.65; Landis and Koch 1977), although more modest for a subset of items (notably, eye contact, reactivity, social interest and affect, and motor control), particularly in 6-month-olds.

Test-retest reliability of the AOSI at age 12 months was assessed by conducting intraclass correlations on the AOSI scores of the different examiners used across each child's two assessment sessions. Although the sample size is small ($n = 20$), test-retest reliability is well within acceptable limits (.61 and.68, for total scores and total marker counts, respectively). In short, then, it would appear that the AOSI provides a reliable means of documenting early signs thought to be indicative of autism.

Predictive Validity of the AOSI

The relationship between early behavioral markers measured by the AOSI and subsequent ASD-related outcomes was initially examined in 65 high-risk infant siblings ("HR infants") and 23 low-risk comparison infants with no family history of ASD ("LR infants") followed to at least 24 months of age. Because of the uncertain stability of clinical diagnosis at this early age, the Autism Diagnostic Observation Schedule (ADOS; Lord et al. 2000), which provides a standardized quantitative metric of ASD symptoms, was used as a preliminary assessment of outcome (Zwaigenbaum et al. 2005). There was no evidence that AOSI total scores or "risk marker counts" (i.e., the number of items scored "1" or higher) at 6 months discriminated between HR infants with an ADOS classification of autism at 24 months and non-diagnosed HR and LR infants. However, at 12 months, mean total AOSI scores were elevated in the HR-autism group compared to other HR and LR infants, based on one-way ANOVA ($F_{3,84} = 25.4$; $P < 0.001$). Moreover, the total number of risk markers observed at 12 months predicted ADOS classification at 24 months. For example, the presence of 7 or more risk markers at 12 months identified 6 of 7 children classified with autism at 24 months, compared to 2 of 58 non-autistic siblings and 0 of 23 controls. Individual 12-month AOSI items that predicted autism classification at 24 months included atypical eye contact, visual tracking, orienting to name, imitation, social smiling, reactivity, social interest and affect, and sensory-oriented behaviors. Subsequent analyses on the same sample expanded through subsequent recruitment and follow-up indicated that of those who received a clinical diagnosis of autism at the age of 3 years, 11 of 14 had a total AOSI score of 9 or more at 12 months (Brian et al. 2006).

Our group (Brian et al. 2008) also examined the predictive validity of the AOSI at 18 months. A sample of 155 HR and 73 LR infants were prospectively assessed

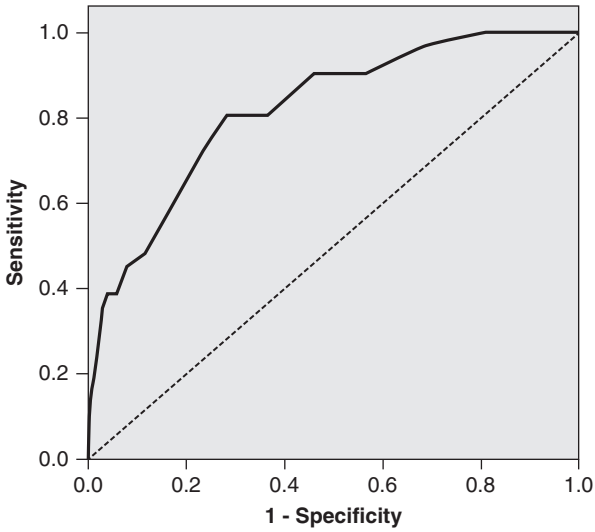

Fig. 1 Receiver operating curve (ROC) of AOSI total scores at 12 months in high-risk infant siblings – autistic disorder outcomes

on the AOSI at 18 months, and an independent gold-standard diagnostic assessment for ASD was conducted at 3 years of age. AOSI items at 18 months that discriminated between HR infants subsequently diagnosed with ASD, non-diagnosed HR infants, and LR infants included atypical orienting to name, differential response to facial emotion, eye contact, reciprocal social smile, reactivity, social interest and affect, difficulty with transitions, poor motor control, and atypical motor and sensory behaviors.

Updated evaluation of the predictive validity and classification accuracy of the AOSI is underway. As the sample size increases (currently, over 300 HR infants with 36-month outcomes), greater variability in early AOSI scores has become apparent among HR infants diagnosed with ASD, particularly among those not meeting ADOS criteria for autism at 24 months (thus, originally not classified as such by Zwaigenbaum et al. 2005). Children diagnosed with ASD (but not meeting full criteria for autism) have a broad distribution of AOSI total scores and marker counts, contributing to lower sensitivity of the AOSI. For example, an AOSI total score of 9 at 12 months (which in an earlier report by Brian et al. 2006, identified 11 of 14 or 79 % of HR infants diagnosed with autism at 36 months) identifies only 34 of 90 HR infants subsequently diagnosed, as well as 35 of 250 HR infants not diagnosed with ASD. This corresponds to sensitivity and specificity estimates of 38 % and 86 %, respectively, and no alternate cut point leads to adequate sensitivity for screening/diagnostic purposes without significantly compromising specificity. Differences in the accuracy with which the AOSI predicts autistic disorder and ASD, based on current data, are illustrated in Figs. 1 and 2, respectively. A comparison of the area under the curve in the two figures shows that total AOSI scores at 12 months are better at predicting autistic disorder than ASD (which includes autistic disorder plus less severe forms of autism). That is, for a given specificity, sensitivity of total AOSI scores is higher for autistic disorder than the more inclusive ASD.

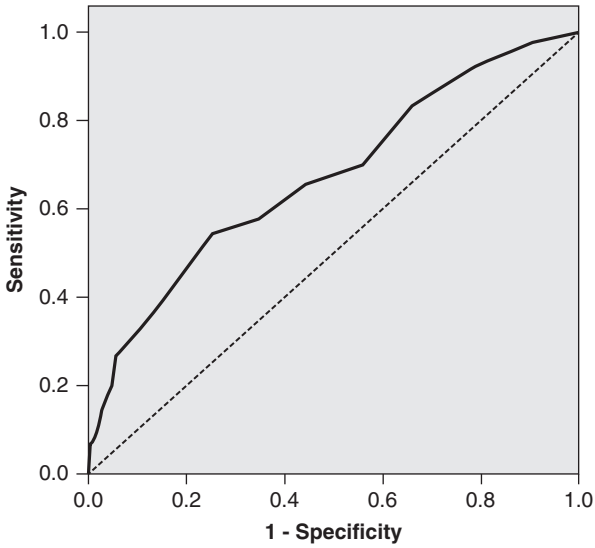

Fig. 2 ROC of AOSI total scores at 12 months in high-risk infant siblings – all ASD outcomes

Thus, as noted earlier, there are currently insufficient data to support using the AOSI with any particular cut point for clinical purposes to determine risk of ASD. Nonetheless, evidence presented in this chapter indicates that our newly developed scale provides a reliable means of documenting early signs thought to be indicative of ASD.

Other Studies Using the AOSI

In related research with high-risk infant siblings, we have used the AOSI to examine the nature and timing of onset of early signs of ASD. In a detailed analysis of the first nine infant siblings who received an independent diagnosis of ASD (i.e., blind to all previous assessments) at 3 years of age, we (Bryson et al. 2007) provided evidence for two broadly defined subgroups: The first subgroup had an earlier onset of symptoms (between 6 and 12 months) and were more severely affected by autism. These children were aloof and were extremely difficult to engage or distract from repetitive activities such as flicking a string in peripheral vision or running their fingers through water and then watching the water fall down. They also showed a striking decrement in cognitive development between 12 and 24 or 36 months, with their IQs changing from average or near average at 12 months to scores of 50 or below at 24 and/or 36 months, the latter of which we have confirmed in a formal trajectory analysis in a larger sample (Brian et al. submitted; also see Landa et al. 2012); the second subgroup had a later onset of symptoms (between 12 and 18 months), were less severely affected by autism (i.e., were more socially responsive), and had relatively stable IQs in the average or near average range over the first 3 years

of life. In all nine children, early impairment in social-communicative development coexisted with atypical sensory and/or motor behaviors, as did a temperament profile marked by irritability, distress, and dysregulated state.

The Brian et al. (2008) study, which assessed the predictive validity of the AOSI at 18 months, also examined agreement between the AOSI and the Autism Diagnostic Observation Schedule (ADOS; Lord et al. 2000) and the degree to which the AOSI offers unique information about ASD symptoms relative to the ADOS at that age. Group differences on individual items of each measure conducted at 18 months (the AOSI and the ADOS) were examined using Fisher's exact tests, followed by a discriminant function analysis involving both measures combined. Despite differences in the methods used to assess and rate behaviors, analyses of the data revealed that a set of largely social items common to both measures were particularly good at distinguishing the ASD HR group from the other two groups (the non-ASD HR group and the LR controls). These included impoverished response to name, social smiling, eye contact, shared enjoyment/social interest, atypical motor behavior, and atypical sensory responses to the environment. Additional good discriminators from the ADOS came from the communication domain (reduced pointing and gestures) and the behavioral domain (repetitive interests, hand and finger mannerisms, and sensory interests). Additional items from the AOSI contributed significantly and uniquely to the prediction of ASD diagnoses at 36 months. These included (in order of relative contribution) difficulty with transitions, poor motor control, and atypical reactivity (hypo- or hyperreactive, with poor regulation of state). Thus, while the hallmark social-affective and communicative impairments diagnostic of ASD are clearly strong early markers of these disorders, it bears emphasizing that evidence is also provided for early impairment in the development of more basic sensory and motor systems. We also emphasize that the two in combination may be particularly predictive of ASD.

In a more recent study, we (Georgiades et al. in press) asked the question of whether autistic-like traits are evident in infant siblings who are not diagnosed with ASD at 3 years of age. For this purpose, a cluster analysis was conducted on total AOSI scores at 12 months of non-ASD HR infant siblings ($n = 170$) and LR controls ($n = 90$). A 2-cluster solution was specified a priori to test the hypothesis that the sample would consist of 2 distinct groups: those with and those without autistic-like traits, as measured by high and low AOSI scores, respectively. Results revealed 2 distinct clusters with significantly different mean total AOSI scores at 12 months. Infants in cluster 1 ($n = 37$), including 33 non-ASD siblings (19.4 % of that group) and only 4 controls (4.5 % of that group), had more autistic-like traits, with a mean total AOSI score of 10 (SD = 3). The remaining infants were assigned to cluster 2 and had a mean total AOSI score of 2. Compared to the LR controls, the non-ASD HR infant siblings had a relative risk of 4.3 for membership in cluster 1. At age 3 years, children in cluster 1 had higher social-communication impairment scores, as indexed by the ADI-R (Lord et al. 1994). They also had lower cognitive scores, as indexed by the Mullen Scales of Early Learning. Taken together, these findings may be the first prospective demonstration of the broader autism phenotype emerging by

age 12 months in non-diagnosed family members. Moreover, this study indicates that some HR siblings with elevated AOSI scores at 12 months may not progress toward an ASD diagnosis, but rather show resolution of symptoms, further emphasizing the need for caution regarding clinical interpretation of the AOSI.

Conclusions and Future Directions

Evidence indicates that the AOSI is a reliable instrument for detecting and monitoring signs of ASD in infants aged 6–18 months. However, current estimates of sensitivity preclude its clinical use as an early screen for risk of ASD. Data from the AOSI suggest that there is wide variability in the nature and timing of onset of ASD symptoms. We have identified two broadly defined subgroups: Children in the subgroup with an early onset of symptoms (6–12 months) are severely affected by autism and show a striking decrement in IQ scores between age 12 and 24 or 36 months; children in the other subgroup have a later onset of symptoms (12–18 months), are less severely affected by autism, and have relatively stable average or near average IQ scores across the first 3 years of life. The AOSI appears particularly insensitive to highly verbal children who are more mildly affected by autism but nonetheless meet criteria for ASD at age 3 years. Identification of these children within a sample of high-risk infant siblings may be further complicated by our finding that autistic-like traits are evident in a subgroup of infants who are not subsequently diagnosed with ASD. Clearly, a challenge for future research is to better understand the early developmental trajectories of children who are the least severely affected by autism and to differentiate them from those who manifest autistic traits but do not meet the full criteria for an ASD diagnosis. It will also be important for future research to examine the stability of early ASD diagnoses. Despite the challenges of establishing a definitive ASD diagnosis prior to 18 months, the identification of behavioral signs associated with ASD risk using the AOSI may help target high-risk infants at greatest need for intervention. We have been using the AOSI to recruit these infants for research on the efficacy of our newly developed *Social ABCs*: A parent-mediated intervention for toddlers with suspected ASD (Brian et al. 2012).

Key Facts

- Autism and its related conditions (known collectively as the Autism Spectrum Disorders) occur with a high prevalence and incur a substantial financial burden on families and society.
- Evidence of improved outcomes in children with ASD with early autism-specific intervention has rendered the early detection and treatment of autism a health priority.
- Progress in developing an effective early screen for ASD has been impeded by the marked heterogeneity in the expression of these disorders.

Summary Points

- The Autism Observation Scale for Infants (AOSI) was developed to detect and monitor signs of autism in 6–18-month-old high-risk infants, all with an older sibling with Autism Spectrum Disorder (ASD).
- The AOSI is a reliable measure of early signs of ASD.
- Current estimates of the sensitivity of the AOSI preclude its clinical use as an early screen for ASD risk.
- At age 12 months, the AOSI is particularly insensitive to highly verbal children who are the least severely affected by ASD.
- Twelve-month AOSI data implicate two broadly defined subgroups among those later diagnosed with ASD: an earlier (6–12-month) symptom onset subgroup who are severely affected by autism and show a striking decrement in IQ scores from average or near average at 12 months to scores of 50 or below at 24 or 36 months and a later (12–18-month) onset subgroup who are less severely affected by autism and have relatively stable average or near average IQs over the first 3 years of life
- These latter findings suggest that the AOSI may be helpful in identifying children most in need of very early intervention.
- Signs of ASD at 18 months predictive of ASD diagnoses at 36 months include impairments in social communication (e.g., reduced orienting to name, eye contact, shared enjoyment/social interest, pointing and gestures), in behavior (e.g., repetitive interests, difficulties with transitions), and in sensory and motor systems (e.g., hand and finger mannerisms, poor motor control, atypical sensory and motor behaviors).
- The prospective identification of autistic-like traits in 12-month-old high-risk infant siblings not later diagnosed with ASD suggests that the broader autism phenotype is evident in family members from very early in life.

References

Adrien JL, Barthelemy C, Perrot A, Roux S, Lenoir P, Hameury L, et al. Validity and reliability of the infant behavioral summarized evaluation (IBSE): a rating scale for the assessment of young children with autism and developmental disorders. J Autism Dev Disord. 1992;22(3):375–94.

Brian J, Roncadin C, Bryson SE, Smith IM, Roberts W, Szatmari P, et al. Emerging cognitive profiles in toddlers with autism spectrum disorders. J Child Psychol Psychiatry. Submitted.

Brian JA, Zwaigenbaum L, Bryson SE, Roberts W, Szatmari P, Smith IM. Predictive validity of the autism scale for infants. Presented at International Meeting for Autism Research (IMFAR); Montreal; 2006.

Brian J, Bryson SE, Garon N, Roberts W, Smith IM, Szatmari P, et al. Clinical assessment of autism in high-risk 18-month-olds. Autism: Int J Res Pract. 2008;12(5):433–56. doi:10.1177/1362361308094500.

Brian JA, Bryson SE, Smith IM, McCormick T, Roberts W, Zwaigenbaum L. The Social ABCs for toddlers with suspected autism: pilot evaluation of a parent-mediated intervention. Poster presented at International Meeting for Autism Research (IMFAR); Toronto; 2012.

Bryson SE, McDermott C, Rombough V, Brian J, Zwaigenbaum L. The autism observation scale for infants. Unpublished manuscript; 2000.

Bryson SE, Zwaigenbaum L, Brian J, Roberts W, Szatmari P, Rombough V, et al. A prospective case series of high-risk infants who developed autism. J Autism Dev Disord. 2007;37(1):12–24. doi:10.1007/s10803-006-0328-2.

Bryson SE, Zwaigenbaum L, McDermott C, Rombough V, Brian J. The autism observation scale for infants: scale development and reliability data. J Autism Dev Disord. 2008;38(4):731–8. doi:10.1007/s10803-007-0440-y.

Dawson G, Osterling J, Meltzoff AN, Kuhl P. Case study of the development of an infant with autism from birth to two years of age. J Appl Dev Psychol. 2000;21(3):299–313.

Georgiades S, Szatmari P, Zwaigenbaum L, Bryson SE, Brian J, Roberts W, et al. A prospective study of autistic-like traits in unaffected siblings of probands with autism spectrum disorder. Arch Gen Psychiatry. In press.

Gillberg C, Ehlers S, Schaumann H, Jakobsson G, Dahlgren SO, Lindblom R, et al. Autism under age 3 years: a clinical study of 28 cases referred for autistic symptoms in infancy. J Child Psychol Psychiatry. 1990;31(6):921–34.

Landa RJ, Gross AL, Stuart EA, Bauman M. Latent class analysis of early developmental trajectory in baby siblings of children with autism. J Child Psychol Psychiatry. 2012. doi:10.1111/j.1469-7610.2012.02558.x.

Landis JR, Koch GG. The measurement of observer agreement for categorical data. Biometrics. 1977;33(1):159–74.

Lord C, Rutter M, Le Couteur A. Autism diagnostic interview-revised: a revised version of a diagnostic interview for caregivers of individuals with possible pervasive developmental disorders. J Autism Dev Disord. 1994;24(5):659–85.

Lord C, Risi S, Lambrecht L, Cook Jr EH, Leventhal BL, DiLavore PC, et al. The autism diagnostic observation schedule-generic: a standard measure of social and communication deficits associated with the spectrum of autism. J Autism Dev Disord. 2000;30(3):205–23.

Ozonoff S, Young GS, Carter A, Messinger D, Yirmiya N, Zwaigenbaum L, et al. Recurrence risk for autism spectrum disorders: a baby siblings research consortium study. Pediatrics. 2011;128(3):e488–95. doi:10.1542/peds.2010-2825.

Sheinkopf S, lester B, Lagasse L, Bauer C, Shankaran S, Bada H. A case study of autism in early infancy. Paper presented at The American Academy of Child and Adolescent Psychiatry 47th Annual Meeting; New York; 2000.

Zwaigenbaum L, Bryson S, Rogers T, Roberts W, Brian J, Szatmari P. Behavioral manifestations of autism in the first year of life. Int J Dev Neurosci: Off J Int Soc Dev Neurosci. 2005;23(2–3):143–52. doi:10.1016/j.ijdevneu.2004.05.001.