Case Study of the Development of an Infant with Autism from Birth to Two Years of Age

Geraldine Dawson, Julie Osterling, Andrew N. Meltzoff, and Patricia Kuhl
University of Washington

This report describes a case study of the development of an infant with autism who was observed closely by professionals from birth and to whom a comprehensive psychological evaluation was administered at approximately 1 and 2 years of age. During the first 6 months of life, this infant displayed difficulties in oral motor coordination and muscle tone that fluctuated between hypotonia and hypertonia. He startled easily, had poor state regulation, and was hypersensitive to touch. Notably, however, during the first 6 months, this infant vocalized and responded socially to others by smiling and cooing. During the second half of the first year, he continued to demonstrate diffuse sensorimotor difficulties and diminished oral motor control. Hypersensitivity now extended to a wider range of stimuli. He had problems in sleep regulation. Motor stereotypies, including rocking, head banging, and toe walking, were observed. Difficulties in the domain of social interaction began to emerge during the second 6 months, including poor eye contact, failure to engage in imitative games, and lack of imitative vocal responses. By a little over 1 year of age, this infant met diagnostic criteria for autism based on the Autism Diagnostic Interview. There were several domains in which this toddler with autism did not show impairments. In the areas of immediate memory for actions, working memory, response inhibition, and speech perception, this 1-year old with autism displayed no evidence of significant impairment on the tests administered. This case study offers clues regarding the nature of autism at its earliest stages. Understanding early development in autism will be important for developing early screening and diagnostic tools.

Autism typically is not diagnosed until the child is of preschool age, making it difficult to study the early development of infants and toddlers with autism. Research on preschool-aged children with autism has helped to clarify the nature of early emerging symptoms and has encouraged professionals to attempt to identify autism during infancy. Many of the symptoms now believed to characterize autism during the preschool years, such as impairments in eye contact, shared affect, social orienting, motor imitation, and joint attention, are ones that theoretically could be appar-

Direct all correspondence to: Geraldine Dawson, Center on Human Development and Disability, Box 357920, University of Washington, Seattle, WA 98195 <dawson@u.washington.edu>.

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ent during infancy and early toddlerhood. However, detailed accounts of infant development in autism are rare. To date, virtually all of our knowledge of autism during infancy has come from either retrospective parent reports or observations based on home videotapes recorded by parents (e.g., Osterling & Dawson, 1994).

In this report, we present a case study of the development of an infant with autism who was observed closely by professionals from birth and to whom a comprehensive psychological evaluation was administered at approximately 1 and 2 years of age at the University of Washington's Center on Human Development and Disability. This report provides one of the earliest detailed accounts of the development an infant with autism to date. Our aim was to elucidate the nature of autism in its early stages and to provide useful information for developing early screening tools for autism.

Case Report

The infant with autism (or I.A.) lived at home with his parents, two older brothers, and one younger brother. At the time this report was written, I.A. was a toddler. I.A.'s father reportedly had motor coordination and attention problems. According to a parental report, the father's sister was diagnosed with obsessive-compulsive disorder and depression. I.A.'s mother reported being shy as a child. I.A.'s oldest brother had been diagnosed with Asperger syndrome based on a multidisciplinary evaluation conducted at the University of Washington and had difficulties with balance, coordination, motor planning, attention, distractibility, and anxiety. By parent report, I.A.'s other brother displayed mild social difficulties, motor coordination problems, mild language delay, attention problems, and a high activity level.

Prenatal, Birth, and Perinatal History

According to pediatric records, I.A. was the product of a pregnancy with first trimester spotting (treated with progesterone), normal fetal activity, and no maternal illnesses or toxin exposure. At 35 weeks gestation, the mother developed spotting, and subsequently a vertex vaginal delivery occurred just before 36 weeks gestation.[1] Birth weight was 6 lbs. 9 oz. with good spontaneous cry and respiration. I.A. came home the day after birth. Shortly thereafter, I.A. developed jaundice and home phototherapy was started. During this period, I.A. showed a decline in what previously was a well-developed suck. The jaundice resolved, but thereafter, according to pediatric records, the mother believed that I.A. did not return to breast feeding as well as he had before. In addition, the mother noted a marked fluctuation in I.A.'s tone, some days being high and rather stiff with fisting, arching, and hypersensitivity, and other days being relatively hypotonic and inactive.

At 1 month of age, I.A. was referred by his pediatrician for an oral-motor evaluation because of difficulties with breast feeding. The occupational therapist conducting the exam reported that I.A. displayed low muscle tone in his facial area and demonstrated difficulties coordinating and pacing his sucking-swallowing-breathing during feeding. Because of these oral-motor difficulties, I.A. was evaluated frequently by occupational therapists and a pediatric neurologist during his first

year of life. The authors subsequently obtained copies of these evaluations, which allowed for a detailed description of his early development. In this report, there was an attempt to use the exact phrases, or only slightly paraphrased versions, of the phrases used in the evaluations conducted by the professionals who saw I.A. early in his development. Note also that, until the child was approximately 1 year of age, all reports were made before a diagnosis of autism. Ages indicated below refer to corrected age (by 4 weeks).

2.5 Months

Because of concerns regarding sucking difficulties, his mother sought an evaluation by a pediatric neurologist when I.A. was 2.5 months of age. The neurologist noted in his records the following observations: "I.A. had, for the most part, good visual attention, though [sic] at times, it was hard to get his attention. I.A. was easily over-stimulated if too much noise was present, but calmed by 'checking out.' At times, he startled during feeding. He had generally good eye contact, although at times he averted his eyes. He was socially responsive, smiled responsively, made vocalizations, but did not laugh. He was noted to be cuddly. He showed equal movements of his upper extremities, batted and reached for objects, and at times, grasped objects. He did not yet bring hands to midline. It was also noted by the neurologist that I.A. had a prominent gastroesophageal reflux. I.A. had very mild sensorimotor difficulties with generalized increase in extensor tone, axial hypotonia, and a slight decrease in oral motor control. He showed tremulous, poorly graded quality of movement (left greater than right), with relative fisting of left hand, mild hypersensitivity especially to tactile input, no pathologic reflexes, and poor state regulation. Treatment of the gastroesophageal reflux began."

4 Months

I.A. began occupational therapy because of excessive muscle tone noted in all extremities. An initial occupational therapy evaluation revealed that I.A. scored in the twenty-fifth percentile on the Alberta Infant Motor Scale. The occupational therapist noted that I.A. was easily overstimulated, did not tolerate handling well, and demonstrated difficulties calming himself. Muscle tone was observed to fluctuate between normal and high, with tone being very hypertonic in extremities. Spasticity was elicited with a quick stretch in upper and lower extremities. He made a lot of vocalizations during play and responded to social interaction from adults by smiling and cooing. Occupational therapy goals included facilitating proper movement patterns and developing smooth, coordinated movements.

There were continuing concerns regarding I.A.'s gastroesophageal reflux, with continued regurgitation, anxiousness, crying, and refusal during feeding, and episodes of arching, choking, stopping breathing, and refusing to feed. Therefore, a sleep study was conducted in conjunction with a pH probe to ascertain any relation between abnormalities in pH and choking and apneic behavior. Results showed no apneic or bradycardiac events, but highly significant acid reflux associated with heart rate decelerations, crying, and irritability.

9 Months

A follow-up assessment with the pediatric neurologist was conducted. The neurologist noted that, although improvement in the areas of muscle tone and integration of movement had occurred, muscle tone continued to remain somewhat high. Oral motor control and feeding continued to be a concern; lumpy, chunky foods were not tolerated. The neurologist indicated that I.A. continued to demonstrate diffuse sensorimotor difficulties characterized by axial hypotonia, variable increased extremity tone, poorly integrated and graded movements, diminished oral motor control and selective finger movement, and mild brachycephaly. He showed hypersensitivity to approach, loud noise, and tactile contact, and autonomic overarousal. The neurologist also noted that I.A. was crawling and pulling to a stand, starting to cruise while holding on to furniture, and briefly standing by himself. When he did stand, he tended to go up on his toes. While sitting, rocking back and forth and head banging were sometimes observed. The neurologist further made the following observations: "I.A. was very vigilant and aware of his environment." Eye contact was characterized as a "transfixed stare." Also, he reported that I.A. did not yet engage in imitative games, such as clapping his hands in imitative play. Vocal responses were observed to be primarily limited to guttural sounds with few, if any, recognizable consonant or labial sounds and no imitative vocal responses. At play, I.A. was active and busy, exploring objects with a relatively short attention span. Sleep was a concern because I.A. was only sleeping 8 to 9 hours in a 24-hour period. He had difficulty falling asleep and woke frequently during the night, only napping for 45 minutes during the day.

11–13 Months

I.A.'s pediatrician noted that he was "different socially" and had "poor eye contact" during his 1-year well-baby visit. At this time, a comprehensive developmental evaluation was conducted at the University of Washington's Center on Human Development and Disability. Because of concerns regarding very inconsistent responses to sound, a Brainstem Auditory Evoked Response evaluation was conducted. Results indicated that I.A. had normal peripheral hearing sensitivity in both ears with no evidence of abnormal neurologic conduction through the brainstem auditory pathways. Fragile X testing was found to be negative. The Bayley Scales of Infant Development, 2nd. edition, were administered, yielding a developmental index of 82 (twelfth percentile rank; developmental age of 10+ months). The psychologist observed that, although eye contact was "within normal limits," there was some indication of "diminished social responsiveness during periods of eye contact." It was also observed that I.A. tended to become overstimulated if there were more than one or two objects on the table. Increased mouthing of objects and occasional stiffening of the body, as well as insensitivity to pain, was also noted by the examiner.

A physical/occupational therapy evaluation was conducted, during which I.A. was observed to be able to entertain himself for extended periods of time with toys. The occupational therapist noted that I.A. manipulated a variety of toys, including throwing a ball and playing with a pull toy on a string. He occasionally

Table 1. Assessment Methods Used at 13–15 Months of Age

Domain	*Assessment Method*
Diagnostic	Autism Diagnostic Interview—Revised[a]
Speech and Language	Preschool Language Scale
	MacArthur Communicative Development Inventory
	Speech perception—vowel and consonant discrimination[b]
Visual–Spatial	Visual–spatial battery[c]
Social–Communicative	Observation of mother–child and clinician–child free play
	Early Social Communication Scales[d]
	Experimental assessment of joint attention[c]
	Experimental assessment of orienting behavior[c]
Motor Imitation and Object Permanence	Immediate motor imitation and object permanence batteries[e]
Neuropsychological	Visual paired comparison (recognition memory/novelty preference)[c]
	Delayed rersponse task (working memory)[c]

[a] Lord, Rutter, & LeCouteur, 1994.
[b] Kuhl, 1985.
[c] Dawson, Meltzoff, Osterling, & Rinaldi, 1998; Dawson, Meltzoff, Osterling, & Brown, 1998.
[d] Mundy, Sigman, Ungerer, & Sherman, 1986.
[e] Meltzoff, 1988; Rast & Meltzoff, 1995.

made eye contact, but otherwise could not be engaged in ongoing interaction either verbally or through eye contact and smiling. He would avert his gaze when the examiner looked at him. He vocalized expressively, but did not direct these to any individual (mother or examiner). On the Bayley Scales of Development—Motor Scale, I.A. achieved a Developmental Index of 77. He cruised around furniture, lowered himself from standing to the floor, and threw a ball. Even with support, he did not demonstrate a coordinated stepping pattern. He was able to use a neat pincer grasp. Muscle tone was mildly increased. He showed evidence of a neonatal positive support reflex as he tended to stand on his toes. Although he was thought possibly to have a mild balance impairment in the upright position, it was noted that he had intact balance and equilibrium reactions in sitting and vertical suspension. The possibility of mild ataxia was raised. Fine motor skills were generally intact.

13–15 Months

At 13 to 15 months of age, I.A. was evaluated by the authors using a variety of standardized diagnostic and assessment procedures outlined in Table 1.

Results

Autism Diagnostic Interview—Revised

The Autism Diagnostic Interview—Revised (ADI-R; Lord, Rutter, & LeCouteur, 1994) was scored by the first author. I.A.'s total score was 27.5. He clearly met diagnostic criteria for autism based on the Autism Diagnostic Interview—

Revised. In the domain of reciprocal social interaction, the following symptoms were present: B1—failure to use direct gaze (42), to engage in social smiling (43), and to use a range of facial expressions (52) to regulate social interaction; B2—failure to show interest in other children (66) and to respond to other children's approaches (67); B3—lack of showing and directing attention (45) and lack of seeking to share own enjoyment with others (47); B4—abnormal quality of social overtures (51); and inappropriate social responses (57). In the social domain, I.A. scored a total of 14 (cut-off = 10).[2]

In the domain of communication, the following symptoms were present: C1—lack of pointing (30), conventional gestures (31), nodding (32), and shaking of head (33); C4—lack of spontaneous imitation (29) and social imitative play (65). In the communicative domain, I.A. scored a total of 10.5 (cut-off = 7).

In the domain of repetitive behaviors and stereotyped patterns, the following symptoms were present: D3—complex stereotyped mannerisms (84); and D4—repetitive use of objects (72). In the repetitive behavior domain, I.A. scored a total of 3 (cut-off = 3).

Language and Speech Perception

Language. On the Preschool Language Scale (Zimmerman, Steiner, & Pond, 1992), which was administered by the second author, I.A. achieved a standard score of 81, a percentile rank of 16, and an age equivalent score of 8 months. On the MacArthur Communicative Development Inventory, I.A. scored below the 8-month level in the areas of comprehension and production of words and gestures.

Speech Perception. This procedure was conducted in the fourth author's laboratory using a head-turning paradigm (Kuhl, 1985). I.A. was conditioned to turn his head toward an interesting object when he perceived a change in the speech stimuli. In the first session, the stimuli were the isolated vowels /a/ as in "pop" vs. /i/ as in "peep". The vowels were computer synthesized to resemble a male speaker. I.A. completed the training phase during the second day of testing, which is typical of all children tested in this task. I.A. learned the head-turning response very quickly and reached a criterion performance in a very small number of trials, indicating excellent discrimination of these vowels. Because I.A. was so easily able to discriminate vowels, it was decided to test him on a more difficult phonetic contrast, the consonant contrast /r/ versus /l/. The stimuli were female /ra/ vs. female /la/, synthetic tokens. I.A. passed an early training stage with these stimuli, but did not fully complete training. In summary, I.A. readily discriminated vowels and, as expected for this age, had more difficulty with the consonants (Kuhl, 1998).

Nonverbal Cognitive Ability

An estimate of nonverbal cognitive ability was based on a developmentally graded (9–18 months) battery of visual—spatial tasks (primarily form board) derived from the Bayley Scales of Infant Development—2nd Ed. On this battery, which was administered by the second author, I.A. scored at the 13-month level, indicating

nonverbal cognitive ability approximately at chronological age level. Thus I.A. was not considered to have a generalized developmental delay at this point in his development.

Social–Communicative Ability

Observations of Free Play with Mother. I.A. was observed by the first and second authors for 15 minutes from behind a one-way mirror while he played with his mother in a playroom equipped with a variety of developmentally appropriate toys. I.A. exhibited very little eye contact, rarely visually referencing his mother's face. His attentional focus was primarily on the toys. When mother initiated interaction, I.A. pulled away, appearing slightly avoidant of the interaction. He vocalized frequently, but this was not directed toward mother, even when he was distressed and frustrated. He did not use gestures, pointing, showing of objects, nor alternate his gaze between objects and his mother's face. He actively explored a range of toys, but had a short attention span. He appeared to become overstimulated and began running in circles. At this time, his vocalizations became more repetitive. After approximately 15 minutes, the toys were removed from the room and mother was encouraged to engage I.A. in social play. I.A. responded by actively avoiding face-to-face interaction, by pulling away initially. He made no eye contact, even when his mother attempted to engage him in direct face-to-face play. He showed mild resistance to being held. He enjoyed being swung by his mother and began smiling and laughing during physical stimulation. When the first author entered the room, I.A. began pushing a toy truck around the perimeter of the room. He became interested in the edge of the carpet of the room. He could not be engaged in reciprocal play. When a favorite object was placed in a plastic jar with a large lid, I.A. did not request help by handing the jar or by making eye contact with the first author.

Joint Attention. The Early Social Communication Scales (Mundy, Sigman, Ungerer, & Sherman, 1986) was administered by the second author. These scales were developed to elicit and assess joint attention and other early communication skills systematically. On the Early Social Communication Scales, I.A. failed to initiate or respond to any joint attention behaviors, including failure to point or show, except in a few instances during which he alternated gaze between the second author and an object. He engaged in brief interactive, reciprocal play when the play was highly structured and repetitive; during the structured play, he imitated a motion and some vocalizations made by the examiner, imitated the motions of a wind-up duck, and anticipated tickling by making eye contact. He followed a simple verbal command to give the examiner a toy when it was repeated several times. He did not make requests and reached only to obtain an object, not as a gesture.

Joint attention ability was also assessed using a method developed by Butterworth and Jarrett (1991) to assess such skills in infants and toddlers. I.A. was seated at a table on which there was a toy with an experimenter sitting opposite the child. Four yellow crosses were mounted on the wall at the eye level, 30° in front of I.A. on the right and left and 30° behind of I.A. on the right and left. When I.A. was

looking in the direction of the examiner, the examiner did one of the following: (a) pointed to cross that was in front of or behind I.A. or (b) looked at cross that was in front of or behind I.A. In response to these probes, which were interspersed among other activities, I.A. failed to follow any of the examiner's gazes or points. His performance on this task was at or below the average level obtained in a previous study by preschool children with autism (Dawson, Meltzoff, Osterling, & Rinaldi, 1998)

Social Orienting. The ability to orient to social and nonsocial stimuli was assessed by the second author. The stimuli consisted of two social stimuli (clapping hands and calling the child's name) and two nonsocial stimuli (playing a musical jack-in-the-box and shaking a rattle). Each stimulus was presented twice, once in the child's visual field and once behind the child (30° to the right or left). Presentation of stimuli was interspersed in between other tasks. I.A. failed to orient to social stimuli 2 of 4 times (50%) and failed to orient to nonsocial stimuli 1 of 4 times (25%). His performance was comparable with the average performance on this test in a previous study by preschool aged children with autism (Dawson, Meltzoff, Osterling, & Brown, 1998).

Motor Imitation and Object Permanence

The motor imitation and object permanence assessments were conducted in the third author's laboratory. Clinically, during this evaluation, I.A. looked fairly socially responsive and was cooperative. He looked at the examiner and smiled several times. One strikingly unusual behavior observed was that I.A. startled (including eye blink) at sounds that typically do not startle other infants this age, including sounds he made himself by banging objects. He was also extremely attentive to, in fact riveted by, all movements and workings of the objects.

I.A. was shown novel acts in a structured test of immediate imitation and administered an object permanence battery. A range of imitation tasks was used, including novel acts (e.g., touching a panel with the forehead to activate it). The tasks were administered while the experimenter was seated across a small table from I.A. After ensuring that I.A. was paying attention, the examiner demonstrated each particular target act three times. There was no verbal description of the tasks and no physical prompting of the child to try to elicit a response. I.A. did well on the imitation tests, even performing the most novel act, which involving using a head touch to activate an object. He also imitated other novel actions, including pressing a button, pulling apart a dumbbell, and pushing down a collapsible cup. It is noteworthy that the tests were administered in a highly structured way that has been found to facilitate performance in nonverbal infants and children with Down syndrome (Meltzoff, 1988; Rast & Meltzoff, 1995).

On the object permanence battery, I.A. clearly passed the standard A-not-B test and was given a borderline pass for a slightly higher level serial visible displacement. All in all, he was not significantly behind expected performance for his age on the structured imitation and object permanence tasks.

Neuropsychological Tests

Visual Paired Comparison. This medial temporal lobe task assesses recognition memory and novelty preference (Nelson, 1995). I.A. was shown a "junk" object

at the outset of each visual paired comparison trial and allowed to play with the object until he lost interest. After a 5-second delay, I.A. was given a choice of that stimulus or a new one. Six trials were administered before I.A. became uncooperative with this task, and the test had had to be terminated. I.A. chose the novel object on four of the six trials. Typically, infants choose the novel object for virtually all trials. This raises the possibility that I.A. performed below expected level on this task, although the low number of trials administered reduces the confidence with which this conclusion can be drawn.

Delayed Response Task. This dorsolateral prefrontal task assesses working memory and the ability to inhibit a prepotent response (Diamond & Goldman-Rakic, 1989). During this task, I.A. watched as the examiner hid a reward to the left or right (two identical hiding wells). After a delay during which I.A. was distracted, I.A. was allowed to reach for the hidden reward. The side of hiding was reversed after I.A. demonstrated a correct search on two consecutive trials. Twelve trials were administered, including two reversal trials. I.A. made no errors on reversal trials, indicating good performance on this task.

2 Years of Age

Autism Diagnostic Observation Schedule—Generic. At 2 years of age, I.A. was administered the Autism Diagnostic Observation Schedule—Generic (Module 1; DiLavore, Lord, & Rutter, 1995) by the second author. This is a standardized diagnostic evaluation that involves direct observation of the child's behavior in response to probes designed to assess autistic symptom domains. Diagnosis by the Autism Diagnostic Observation Schedule—Generic is based on an empirically validated algorithm related to the *Diagnostic and Statistical Manual of Mental Disorders*, 4th Ed. diagnostic criteria for autistic disorder. On the Autism Diagnostic Observation Schedule—Generic, I.A. qualified for a diagnosis of autism. In the domain of qualitative impairment in reciprocal social interaction, I.A. showed difficulties in the areas of eye contact, communicative facial expressions, shared enjoyment, response to joint attention, and quality of social overtures. He scored 9 points in this domain (cut-off for autism = 7). In the domain of communication, I.A. showed difficulties in the areas of directed vocalizations, use of other's body to communicate, pointing, and gestures. He scored 4 points in this domain (cut-off = 4). In the area of play, I.A. had difficulties in the area of creative/imaginary play. In the domain of stereotyped behaviors and restricted interests, I.A. showed complex motor mannerisms and repetitive interests.

Intellectual Ability. I.A. was administered the Mullen Scales by the second author. These scales assess general intellectual ability, tapping the four subdomains of visual–spatial ability, fine motor skills, and receptive and expressive language. On the Mullens Scales, I.A. achieved an overall Early Learning Composite Score of 63 ($M = 100$) which placed him at the first percentile in terms of overall cognitive ability. I.A.'s performance on the Visual Reception Scale, which assessed visual–spatial ability, placed him at the 18-month level, with a T score of 34 (Average T score = 50, $SD = 10$) and percentile rank of 5, indicating below average skills in this domain. I.A. looked for a toy that was covered and then displaced and placed

at least one shape in a formboard. However, he did not yet match at least one set of objects or put nesting cups in proper order. On the Fine Motor scale, I.A.'s performance placed him at the 20-month level, with a T score of 36 and percentile rank of 8, indicating below average skills in this domain. I.A. could not stack up to nine blocks or make a four-block train (imitating a model). But he could draw a vertical or horizontal line (imitating a model) and put pennies in a horizontal or a vertical slot. On the Receptive Language Scale, I.A.'s performance placed him at the 10-month level, with a T score of 20 and percentile rank of 1, indicating very low ability in this domain. I.A. accomplished tasks such as understanding inhibitory words such as "No" and giving a toy in response to a verbal request and a gesture. He had difficulty touching or pointing to an object after hearing it named and giving a toy in response to a verbal request. On the Expressive Language Scale, I.A.'s performance placed him at the 14-month level, with a T score of 28 and percentile rank of 1, indicating very low ability in this domain. I.A. communicated intentions by using jargon combined with gestures and combined a word and a gesture to make a request. He did not name objects like "car" or "key" or name a picture from a book.

In summary, I.A.'s evaluation at 2 years of age indicated that he qualified for a diagnosis of autism. In terms of cognitive ability, I.A.'s relative strengths were in the fine motor and visual spatial domains. He was functioning in the below average range, but not in the mentally retarded range, in these two domains. In contrast, I.A. showed substantial delays in the domains of receptive and expressive language.

Discussion

In this report, we describe the development of an infant with autism from birth through 2 years of age. At 2 years of age, this child met DMS-IV criteria for autism and, on standardized tests, exhibited below average nonverbal ability along with significantly delayed skills in verbal ability. Thus, this 2-year-old toddler with autism was not globally mentally retarded. Instead, even at this early age, he displayed the uneven cognitive profile of higher visual–spatial than verbal skills that is characteristic of many older children with autism. Interestingly, standardized testing suggested a slight cognitive decline (relative to chronological age) between the ages of 1 and 2 years. Whereas at 1 year of age he achieved a developmental index of 82 (twelfth percentile rank), at 2 years of age he achieved a composite score of 63, which placed him at the first percentile in terms of overall cognitive ability. This apparent decline may reflect the increasing difficulties apparent on tasks involving communication and symbolic functioning.

The emergence of autistic symptoms in I.A. from birth to 1 year of age is summarized in Table 2. During the first 6 months of life, this infant displayed difficulties in the area of oral motor coordination, as evidenced by difficulties in sucking and muscle tone that fluctuated between hypotonia and hypertonia. He startled easily, had poor state regulation, and was hypersensitive to touch. Notably, however, during the first 6 months, this infant vocalized and responded socially to others by smiling and cooing.

Table 2. Emergence of Austistic Symptoms in I.A. From Birth to 15 Months of Age

	Birth to 6 Months	*9 Months*	*12–15 Months*
State Regulation	Poor state regulation	Sleep difficulties	Sleep difficulties
Sensitivity to Stimuli	Hypersensitivity to tactile input	Hypersensitivity to noise, social approach, and tactile input	Hypersensitivity to stimuli from all methods
Motor	Hypertonia/hypotonia	Axial hypotonia; Increased extremity tone;	Increased tone; Possible mild ataxia
	Oral–motor difficulties, especially feeding; Poorly graded movements	Oral-motor difficulties; Poorly integrated and graded movements; Stereotyped movements	
Social Responses		Poor eye contact; Lack of imitation in unstructured social settings	Poor eye contact; Lack of social imitative play Lack of reciprocal play; Restricted range of facial expressions; Lack of social smiling
Prelinguistic Development		Lack of imitative babbling	Failure to use vocalizations communicatively; Lack of joint attention
Repetitive/ Stereotyped Behaviors		Rocking and head banging	Stereotyped behaviors; Repetitive use of objects

During the second half of the first year of life, he continued to demonstrate diffuse sensorimotor difficulties characterized by poorly integrated and graded movements and diminished oral motor control. His hypersensitivity now extended to a wider range of stimuli, including sounds, social approach, and tactile contact. He had problems in sleep regulation. Motor stereotypies, including rocking, head banging, and toe walking were observed. Difficulties in the domain of social interaction were beginning to emerge during this period, including poor eye contact, failure to engage in imitative games, and lack of imitative vocal responses. This is in contrast to earlier reports at 6 months of age, at which time I.A. was reported to be socially responsive. It is possible that social impairments in autism become more evident as social behavior becomes more intentional in nature, especially as the child makes increasingly complex choices about whether and how to engage with another person. Presumably, such intentional social behavior requires higher level brain systems than those required for more perceptually driven social behavior. If such higher level systems are impaired in autism, then problems in social interaction

would be expected to emerge when high-order cortical systems become metabolically active during the second half of the first year of life (Chugani, 1994). Indeed, the early symptoms seen in this child during the first 6 months of life appear to involve subcortical, brain stem, and cerebellar functions. Such symptoms include difficulties in state regulation, sleep, hypersensitivity to stimuli, and motor impairments. By 1 year of age, symptoms involving higher cortical brain regions, such as use of language and gesture, are apparent. Such evidence for the wide range of brain systems involved in autism underscores the complex nature of the neurobiological basis of this disorder.

By a little over 1 year of age, this infant met diagnostic criteria for autism based on the revised version of the Autism Diagnostic Interview. He showed clear impairments in the areas of social interaction and verbal and nonverbal communication, and exhibited repetitive, stereotyped motor behaviors. He had diminished and sometimes avoidant eye contact and inconsistently oriented to social stimuli. He also failed to engage in reciprocal social interaction, including social imitative play, to direct vocalizations communicatively, and to use or respond to joint attention behaviors, including failure to point or show to share enjoyment with others. He displayed complex stereotyped motor mannerisms consisting of running in circles and repetitive use of objects. He continued to be easily overstimulated, for example, if there were more than one to two objects placed in front of him, if he was touched unpredictably, or if held by others. He showed increased mouthing of objects. There was tentative evidence of impairment on a medial temporal lobe task that assessed novelty preference and visual recognition; however, because of lack of cooperation, this assessment is inconclusive.

Interestingly, there were several domains in which this 1-year old with autism did not show impairments. He performed well on highly structured tasks assessing immediate imitation of actions with toys and on two tasks that tapped dorsolateral prefrontal abilities (object permanence and delayed response task). Thus in the domains of immediate memory for actions, working memory, and response inhibition, this 1-year old with autism displayed no evidence of significant impairment on the tests administered. These findings are particularly interesting in light of current theories which emphasize impairments in imitation and frontal lobe functioning as core features of autism (Rogers & Pennington, 1991; Dawson, 1991; Meltzoff & Gopnik, 1993; Smith & Bryson, 1994). An assessment of deferred imitation requiring long term memory for actions was not conducted and would be of interest given the cognitive requirements and brain regions involved in such tests (Dawson, Meltzoff, Osterling & Rinaldi, 1998; Meltzoff, 1995). Moreover, although he was able to perform immediate imitation tasks with objects in a relatively structured, and distraction free testing situation, he failed to engage in social imitative play in less structured situations that entailed social engagement with another person and spontaneous attention to another person's behavior (e.g., during free play with mother).

On tests of speech perception, at one year of age, this infant was able to discriminate vowel sounds but performed less well on consonant sound discrimination. Anecdotally, it is known that this child, now approaching preschool age, has developed expressive language, albeit delayed (he now uses approximately 5 rote

words). It will be of interest to determine in future research whether early tests of speech perception and structured imitation accurately predict which subset of children with autism goes on to develop expressive language.

It is worth underscoring that, at 1 year of age, this infant performed significantly better in highly structured situations in which the number of stimuli was limited and presented in a routine, predictable manner. His improved ability to imitate others in highly structured situations has already been discussed. Other examples are his improved eye contact, social smiling, and rudimentary joint attention skills (alternating gaze) that were observed during the structured joint attention assessment, but not during free play. These observations may be important for designing early screening protocols and intervention strategies. Sensitivity to autistic symptoms may be improved by using less structured, less routine, and predictable assessment paradigms, such as free play. However, effective therapeutic interventions may want to incorporate highly structured, predictable, and routine types of interactions and teaching strategies (Dawson, 1991; Klinger & Dawson, 1992; Lewy & Dawson, 1992).

The evidence provided by this case study suggests, furthermore, that those interested in early identification of autism during the first year of life should consider including assessments of early motor functioning, self-regulatory behaviors, and sensitivity to stimuli, in addition to the more autism-specific domains of social interaction, prelinguistic communication, and toy use. For this child, the earliest symptoms of autism consisted of difficulties in self-regulation and motor function; core symptoms of autism, such as impairments in eye contact, social reciprocity, and communication, were not apparent until later in the first year of life. It is possible that the early impairments in self-regulation and motor function interfered with the normal development of early social and communication skills, as well as with the development of appropriate toy play. Engagement in social and communicative interactions requires the infant to attend to and make meaning out of complex, unpredictable information and involves considerable self-regulation abilities on the part of the infant. If the infant is overaroused by social interactions and other complex stimuli, he or she may fail to attend to and engage in such interactions. Appropriate use of toys, particularly imaginary play, draws on increasingly complex motor planning skills and also is facilitated in the context of social interactions with adults. Thus the early problems in self-regulation and motor function may play a role in the later emerging difficulties in social and communication skills. It may be useful for those designing early intervention programs for infants and toddlers with autism to consider the impact of difficulties in self-regulation and motor function on the acquisition of other skills domains.

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Notes

1. Although I.A.'s birth was early, in light of I.A.'s adequate birth weight and unremarkable prenatal history, the early delivery, by itself, would not account for the subsequent developmental problems I.A. experienced.

2. In the social domain, the item "shows interest in other children" may not be appropriate for a toddler this age. But even without this item, I.A. scored above the cut-off for this domain. Similarly, in the communication domain, "nodding" and "shaking" of head may not be seen consistently at this age. But again, even without these two items, I.A. scored above the cut-off for this domain.

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