Long-term Outcomes of Toddlers With Autism Spectrum Disorders Exposed to Short-term Intervention

abstract

OBJECTIVES: To examine long-term outcomes of toddlers with autism spectrum disorder (ASD) who received a 6-month early intervention at age 2.

METHODS: Forty-eight toddlers diagnosed with an ASD received a 6-month evidence-based intervention. Cognitive (IQ) and communication ability, as well as severity of autism symptoms, were assessed by using standardized measures at preintervention (Time 1 [T1]; mean [M] age = 27 months), postintervention (T2; M age = 35 months), short-term follow-up (T3; M age = 41 months), and long-term follow-up (T4; M age = 72 months).

RESULTS: From pre- to postintervention, significant gains in IQ and Vineland Communication domain standard scores as well as a reduction in ASD severity were achieved (all $P < .01$). Between T2 and T3, the 6-month period immediately after completion of the intervention, IQ and Communication scores stabilized and ASD severity increased significantly ($P < .05$). During the long-term follow-up period (T3–T4), IQ and Communication scores significantly increased again, but ASD severity increased significantly as well (all $P < .05$). For overall trajectory (T1–T4), robust gains were observed for both IQ and communication; ASD severity did not change.

CONCLUSIONS: Findings highlight the potential for positive long-term outcomes in toddlers with ASD. Additional research is needed to understand the relation between early exposure to uninterrupted intervention and developmental gains, and whether initial reduction in ASD symptom severity can be sustained through targeted intervention. *Pediatrics* 2012;130:S186–S190

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KEY WORDS

autism, outcomes, intervention, IQ, toddlers

ABBREVIATIONS

ABA—applied behavior analysis
ADOS—Autism Diagnostic Observation Schedule
ASD—autism spectrum disorder
CI—confidence interval
d—Cohen's d
M—mean
T—Time
VABC—Vineland Adaptive Behavior Composite

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Mounting empirical evidence suggests evidence-based early intervention for children with autism spectrum disorders (ASDs) is associated with cognitive, language, and/or social gains[1–8]; however, little is known about the durability of such gains after transition from early intervention into the preschool and elementary educational years. Research surrounding sustainability of intervention effects has clinical, economic, and quality-of-life implications.

Four published reports have followed 2- or 3-year-olds with ASD for at least 6 months after completion of an early intervention program. In 2 studies, 2-year-olds who received short-term intervention showed sustained social,[4,5] language,[4] and nonverbal cognitive[4] gains through a 6-[4] to 12-month[5] follow-up period. Two other studies reported on longer-term outcomes of 2- and 3-year-olds exposed to a 2-year comprehensive intervention.[6,7] Kovshoff and colleagues[6] reported that IQ, but not Vineland Adaptive Behavior Composite (VABC),[9] increased during receipt of 1:1 applied behavior analysis (ABA) intervention. No IQ or VABC gains were observed from pre- to postintervention in the comparison group receiving public special education.[8] During the postintervention follow-up period, no increases in IQ or VABC scores occurred in either group.[6,8] Outcomes were particularly unfavorable for children in the ABA group whose preintervention IQ was low, as their IQ scores declined significantly during follow-up.[6] Finally, Magiati and colleagues[7] examined long-range trajectories and outcomes of children enrolled at mean (M) age of 3.4 years in a 2-year therapeutic preschool. When reassessed 5 years after departing the preschool, children exhibited no gains in standardized IQ scores and VABC significantly diminished.[7]

The literature reviewed in the preceding paragraph indicates that young children with ASD enrolled in evidence-based intervention show developmental acceleration while receiving the intervention. Upon departure from the intervention being investigated, initial gains are often sustained but no further acceleration occurs. The aim of this study was to elucidate long-term outcome of toddlers with ASD with known early intervention exposure.[4]

METHODS

This study was approved by the Johns Hopkins Medical Institutional Review Board; all families gave written informed consent for the child's participation.

Participants

Participants included 48 children (81% male; 75% Caucasian) with ASD, ages 22 to 33 months (M = 27 months, SD = 2.8 months) at study entry, from a moderate to high socioeconomic background as determined by using the Hollingshead Index of Social Status (Hollingshead AB. Four Factor Index of Social Status. New Haven, CT: Department of Sociology, Yale University), in which higher scores represent higher socioeconomic status (M = 56.4, SD = 7.5); 78% of parents had a Bachelor's degree or higher. Inclusion criteria were the following: meeting Autism Diagnostic Observation Schedule-Generic[10] (ADOS) algorithm criteria (Communication + Reciprocal Social Interaction score) for ASD or autism and receiving a diagnosis of ASD by an expert clinician (1 child met clinical judgment only); chronological age ≤33 months; nonverbal mental age ≥9 months (per Mullen Scales of Early Learning[11] Visual Reception scale); primary language spoken within the home was English; and no known biological cause of ASD.

Subjects were recruited via print material distributed through the Kennedy Krieger Autism Center, advocacy groups, conferences, infants and toddlers programs, physicians' offices, and word-of-mouth. Thirty-four participants were also in the report by Landa and colleagues.[4] Comparison of these 34 participants with the 14 children from our previous report who did not continue receiving long-term follow-up assessments revealed no significant group differences on any of the variables studied herein (see Time 1 [T1]–T4 measures later in this article) at baseline, post intervention, or short-term follow-up assessments.

Assessment Procedures

Children were assessed at preintervention (T1), postintervention (T2, 6 months after T1), 6 months postintervention (T3), and at long-term follow-up (T4). There was little missing data; however, parents' adherence to annual follow-up assessments was mixed. To minimize the effect of missing data, T4 data represent the most current evaluation, allowing us to assess longer-term outcomes. At T1, 2 children were missing Vineland Communication scores. At T4, 1 child was missing ADOS and 6 children were missing IQ scores. Assessments were conducted by Autism Center clinical experts who were unfamiliar to the child; data-entry staff were blinded to group membership and study hypotheses.

Intervention Procedures

At T1, participants were enrolled in a research-based 6-month comprehensive intervention[4] using evidence-based instructional strategies (such as Treatment and Education of Autistic and Related Communication Handicapped Children, Pivotal Response Training, Discrete Trial Training)[12–15] that included ABA, routines-based responsive teaching strategies, and visual cues. Instruction was delivered with high fidelity.[4] A comprehensive curriculum[16] was supplemented with our language and social communication development curriculum. Intervention was provided 10 hours per week within a nursery classroom at the Autism Center, with 5 children, a Master's level teacher, and 2 teaching assistants per class. Parents received weekly on-site education on ASD intervention-relevant content and monthly home-based coaching on implementation of teaching strategies within home routines. According to parent report, the number of children receiving special education or ABA intervention services for part of or throughout the T2 to T3 interval was 38 (92.7%) of the 41 children whose parents completed the treatment history form. From T3 to T4, 32 (66.7%) of the 48 children received such services for part or all of the interval. The number of children receiving additional intervention services (eg, speech-language, occupational therapy) from T2 to T3 was 40/44 (90.9%) and from T3 to T4 was 36/48 (75%).

Dependent Measures

All of the dependent measures used in this study were administered at each time point. Although we administered other measures of language functioning, for example, those measures changed as children increased in age and did not provide a common metric of functioning over time. For this reason, those measures are not included in this report.

ASD Symptom Severity

To assess ASD symptom severity, the ADOS[10] was administered by a research reliable clinician. This "gold-standard" ASD standardized semistructured play-based assessment provided researchers with a 3-point scoring option for items relevant to ASD symptomatology. It has strong psychometric properties, including inter-rater reliability.[10] To examine change in ASD symptoms over time, a standardized system of calculating ASD symptom severity from ADOS scores was used.[17] Ranging from 1 to 10, with higher scores indicating greater ASD symptom severity, this metric combines social, communication, and repetitive behaviors from the revised ADOS algorithm[18] into a summary score that accounts for differences in child age and communication level.

IQ

Intellectual functioning was estimated by using the Mullen Scales of Early Learning: AGS Edition[11] or Stanford-Binet Intelligence Scales, 5th Edition.[19] The Mullen is a standardized developmental test for children between 3 and 69 months with demonstrated reliability, validity, and utility among young children with developmental disabilities. From T1 to T3, all children received the Mullen. At T4, most children (n = 36; 86%) received the Stanford-Binet; the remainder received the Mullen. Both tests yield a general quotient of development (Mullen Early Learning Composite; Stanford-Binet Full Scale IQ) with M = 100 and SD = 15, used here to examine change in cognitive level.

Communication Skills

The Vineland Adaptive Behavior Scales, Second Edition, Survey Interview Form[9] was administered as an interview by a trained clinical researcher to primary caregivers. The Vineland has been shown to be sensitive to changes in development over time,[20] and is a valid and reliable semistructured caregiver interview. The Communication Domain standard score (M = 100, SD = 15) was used to assess changes in child receptive, expressive, and written communication skills.

Analytic Procedures

To account for the correlational structure of the data, multilevel (random-effects or hierarchical[21]) models were used to examine growth between each time point while placing a random effect on a child. Specifically, linear models were used to examine mean differences between time points (ie, the slope). To assess effect size, Cohen's[22] d was calculated as the slope divided by the pooled SD. β coefficients from the regression models, as well as accompanying 95% confidence intervals (CIs), are provided in the results section, whereas descriptive statistics and effect sizes are listed in Table 1.

RESULTS

T1 Sample Characteristics

Baseline (T1) IQ, Vineland Communication, and ADOS severity scores are presented in Table 1. Eighty-one percent and 58% of the children in this sample had standardized IQ and Vineland Communication scores <70, respectively. Mean ADOS algorithm score (Communication + Reciprocal Social Interaction score) was 15.80 (SD = 3.9).

TABLE 1 T1 to T4 IQ, Vineland Communication Domain Standard Score, and ADOS Autism Symptom Severity

Period Age, mo (M, SD)	IQ			Vineland Communication Domain Standard Score			Autism Symptom Severity		
	n	Mean (SD)	d	n	Mean (SD)	d	n	Mean (SD)	d
T1 (27.2, 2.8)	48	60.1 (11.9)	—	46	69.7 (9.6)	—	48	7.3 (2.2)	—
T2 (35.0, 2.9)	48	68.1 (19.6)	0.49[b]	48	74.4 (12.4)	0.42[a]	48	5.5 (2.6)	−0.75[c]
T3 (41.1, 3.1)	48	67.6 (20.6)	−0.01	48	75.8 (16.1)	0.11	48	6.5 (2.3)	0.41[b]
T4 (72.6, 17.5)	42	81.5 (24.4)	0.52[c]	48	82.4 (20.4)	0.38[b]	47	7.4 (2.0)	0.46[a]
T1–T4 change	42	21.4 (22.9)	1.02[c]	46	12.7 (19.4)	0.81[c]	47	0.1 (2.5)	0.05

—, T2 reference.
[a] $P < .05$.
[b] $P < .01$.
[c] $P < .001$.

IQ, ASD Severity, and Communication Trajectories

A significant mean increase in norm-referenced standard IQ scores was found between T1 and T2 (β = 8.1, 95% CI: 3.4 to 12.8), and T3 and T4 (β = 11.7, 95% CI: 7.1 to 16.3). Although no significant difference was found between T2 and T3 (β = –0.4, 95% CI: –3.3 to 2.6), gains in overall trajectory between T1 and T4 were robust (β = 19.6, 95% CI: 14.7 to 24.5).

For communication, a significant mean increase in norm-referenced communication scores was found between T1 and T2 (β = 4.7, 95% CI: 0.6 to 8.8), and T3 and T4 (β = 7.0, 95% CI: 2.8 to 11.1). Although no difference was found between T2 and T3 (β = 1.6, 95% CI: –0.5 to 3.3), mean overall gains in communication between T1 and T4 were large (β = 13.0, 95% CI: 9.0 to 17.0). By age 6 years, IQ (M = 81.5; SD = 24.4) and standardized communication scores (M = 82.4; SD = 20.4) for two-thirds of the sample were >70, indicating a high level of functioning.

For ASD severity, a significant decrease in symptoms (improvement) was found between T1 and T2 while children were enrolled in the early intervention (β = –1.8, 95% CI: –2.5 to –1.1). Conversely, there was a significant increase in ASD symptoms (worsening) between T2 and T3 (β = 1.0, 95% CI: 0.3 to 1.6) and T3 and T4 (β = 1.0, 95% CI: 0.2 to 1.6). Examining across the T1 to T4 span, no differences in ASD symptoms existed (β = 0.07, 95% CI: –0.6 to 0.8). The Ms, SDs, and effect sizes (*d*) for the ASD severity, IQ, and Vineland Communication measures are shown in Table 1.

DISCUSSION

Outcomes of toddlers enrolled in a 6-month nursery-school–based intervention[4] at age 2 years were examined. Between preintervention assessment (T1; mean age 27 months) and the long-term follow-up assessment (T4), conducted at a mean of 37.6 months after children completed the intervention, significant gains in IQ and Vineland Communication domain standard scores were achieved. Increases in standard scores reflect a rate of development that outpaced rate of advancing chronological age. Yet, the increases were not evenly distributed across the intervals. Robust gains were observed from pre- to postintervention (T1–T2), followed by a period of stabilization (T2–T3), which was followed by a second developmental burst (T3–T4). Trajectory of autism symptom severity was markedly different from IQ and communication trajectories. That is, ASD severity significantly decreased between T1 and T2, paralleling the initial robust gain in IQ and communication development achieved during the early intervention. Upon cessation of the intervention, ASD severity began to increase. By T4, it had returned to the preintervention level.

Without a control group, the factors contributing to the gains observed from T1 to T2 cannot be identified readily (ie, maturation versus intervention effects). Yet a role for intervention in these gains is conceivable, given the temporal alignment of developmental increases and diminishing ASD severity with intervention exposure followed by a leveling of IQ and communication standard scores, as well as a rise in ASD severity after cessation of the intervention. Benchmarks for maturation or change associated with community-based intervention are available in Dawson and colleagues' randomized control trial[2] involving an ASD sample having enrollment characteristics similar to those of our sample. Changes in the current study from T1 to T2 were roughly twice the magnitude, despite half the duration of intervention exposure at age 2 years, when compared with that of the community-based sample.

The finding of a second period of accelerated development in children with ASD from preschool- to early school-age has considerable clinical relevance. At this age, children begin to receive full-day educational services, which may be linked to the observed developmental surge. Despite these improvements, ASD symptom severity increased on departure from our early intervention that strategically targeted communication, language, and social functioning. This highlights the importance of ongoing, uninterrupted exposure to intervention strategically targeting core ASD symptoms. Such continuity of targeted intervention may result in more comprehensive and sustained improvements.

This study has several limitations. These include the absence of a comparison group of children not exposed to the early intervention. Thus, postintervention gains cannot be definitively attributed to the intervention. Finally, school-age IQ data were missing for 6 children. These children had VABC scores below 70 at T4 and are presumed to be at risk for cognitive delay, which may have attenuated the estimate of cognitive gains at T4 in our sample.

Future studies are needed to determine whether there are sensitive periods of development in which children with ASD learn most efficiently and the conditions that affect optimality of outcome (eg, duration, intensity, instructional strategies, and curriculum content). Determining whether certain types of intervention or age of exposure to intervention have protective effects on long-term outcomes is also greatly needed.

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REFERENCES

1. Rogers SJ, Vismara LA. Evidence-based comprehensive treatments for early autism. *J Clin Child Adolesc Psychol*. 2008;37(1):8–38
2. Dawson G, Rogers S, Munson J, et al. Randomized, controlled trial of an intervention for toddlers with autism: the Early Start Denver Model. *Pediatrics*. 2010;125(1). Available at: www.pediatrics.org/cgi/content/full/125/1/e17
3. Kasari C, Freeman S, Paparella T. Joint attention and symbolic play in young children with autism: a randomized controlled intervention study. *J Child Psychol Psychiatry*. 2006;47(6):611–620
4. Landa RJ, Holman KC, O'Neill AH, Stuart EA. Intervention targeting development of socially synchronous engagement in toddlers with autism spectrum disorder: a randomized controlled trial. *J Child Psychol Psychiatry*. 2011;52(1):13–21
5. Kasari C, Gulsrud AC, Wong C, Kwon S, Locke J. Randomized controlled caregiver mediated joint engagement intervention for toddlers with autism. *J Autism Dev Disord*. 2010;40(9):1045–1056
6. Kovshoff H, Hastings RP, Remington B. Two-year outcomes for children with autism after the cessation of early intensive behavioral intervention. *Behav Modif*. 2011;35(5):427–450
7. Magiati I, Moss J, Charman T, Howlin P. Patterns of change in children with autism spectrum disorders who received community based comprehensive interventions in their pre-school years: A seven year follow-up study. *Res Autism Spectr Disord*. 2011;5(3):1016–1027
8. Remington B, Hastings RP, Kovshoff H, et al. Early intensive behavioral intervention: outcomes for children with autism and their parents after two years. *Am J Ment Retard*. 2007;112(6):418–438
9. Sparrow S, Balla D, Cicchetti D. *Vineland Adaptive Behavior Scales: Interview Edition*. Circle Pines, MN: American Guidance Service; 1984
10. Lord C, Rutter M, DiLavore PC, Risi S. *Autism Diagnostic Observation Schedule*. Los Angeles, CA: Western Psychological Services; 2002
11. Mullen EM. *Mullen Scales of Early Learning—AGS edition*. Circle Pines, MN: American Guidance Service; 1995
12. Carr EG, Binkoff JA, Kologinsky E, Eddy M. Acquisition of sign language by autistic children. I: Expressive labelling. *J Appl Behav Anal*. 1978;11(4):489–501
13. Lord C, Bristol MM, Schopler E. Early intervention for children with autism and related developmental disorders. In: Schopler E, Van Bourgondien M, Bristol Sc M, eds. *Preschool Issues in Autism*. New York: Plenum Press; 1993:199–221
14. Lovaas OI. Behavioral treatment and normal educational and intellectual functioning in young autistic children. *J Consult Clin Psychol*. 1987;55(1):3–9
15. Schreibman L, Koegel RL. Fostering self-management: parent-delivered pivotal response training for children with autistic disorder. In: Hibbs E, Jensen P, eds. *Psychosocial Treatments for Child and Adolescent Disorders: Empirically Based Strategies for Clinical Practice*. Washington, DC: American Psychological Association; 1996:525–552
16. Bricker D. *Assessment, Evaluation, and Programming System for Infants and Children: Birth to Three Years*. 2nd ed. Baltimore, MD: Brookes; 2002
17. Gotham K, Pickles A, Lord C. Standardizing ADOS scores for a measure of severity in autism spectrum disorders. *J Autism Dev Disord*. 2009;39(5):693–705
18. Gotham K, Risi S, Pickles A, Lord C. The Autism Diagnostic Observation Schedule: revised algorithms for improved diagnostic validity. *J Autism Dev Disord*. 2007;37(4):613–627
19. Roid GH. *Stanford-Binet Intelligence Scales*. 5th ed. Itasca, IL: Riverside Publishing; 2003
20. McGovern CW, Sigman M. Continuity and change from early childhood to adolescence in autism. *J Child Psychol Psychiatry*. 2005;46(4):401–408
21. Laird NM, Ware JH. Random-effects models for longitudinal data. *Biometrics*. 1982;38(4):963–974
22. Cohen J. *Statistical Power Analysis for the Behavioral Sciences*. 2nd ed. Hillsdale, NJ: Lawrence Erlbaum Associates; 1998

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