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### Title

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### Permalink

<https://escholarship.org/uc/item/2mn000m0>

### Journal

Journal of the American Academy of Child and Adolescent Psychiatry, 54(7)

### ISSN

0890-8567

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### Publication Date

2015-07-01

### DOI

10.1016/j.jaac.2015.04.005

Peer reviewed

# Long-Term Outcomes of Early Intervention in 6-Year-Old Children With Autism Spectrum Disorder

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**Objective:** We prospectively examined evidence for the sustained effects of early intervention based on a follow-up study of 39 children with ASD who began participation in a randomized clinical trial testing the effectiveness of the Early Start Denver Model (ESDM) at age 18 to 30 months. The intervention, conducted at a high level of intensity in-home for 2 years, showed evidence of efficacy immediately posttreatment.

**Method:** This group of children was assessed at age 6 years, 2 years after the intervention ended, across multiple domains of functioning by clinicians naive to previous intervention group status.

**Results:** The ESDM group, on average, maintained gains made in early intervention during the 2-year follow-up period in overall intellectual ability, adaptive behavior, symptom severity, and challenging behavior. No group differences in core autism symptoms were found immediately posttreatment; however, 2 years later, the ESDM group demonstrated improved core autism symptoms and adaptive behavior as compared

with the community-intervention-as-usual (COM) group. The 2 groups were not significantly different in terms of intellectual functioning at age 6 years. Both groups received equivalent intervention hours during the original study, but the ESDM group received fewer hours during the follow-up period.

**Conclusion:** These results provide evidence that gains from early intensive intervention are maintained 2 years later. Notably, core autism symptoms improved in the ESDM group over the follow-up period relative to the COM group. This improvement occurred at the same time that the ESDM group received significantly fewer services. This is the first study to examine the role of early ESDM behavioral intervention initiated at less than 30 months of age in altering the longer-term developmental course of autism.

**Key Words:** early, intervention, autism, long-term, outcomes

*J Am Acad Child Adolesc Psychiatry* 2015;54(7):580–587.

Early intensive behavioral intervention is recognized as an efficacious approach for improving outcomes for young children with autism spectrum disorders (ASD). Intellectual ability, communication and language functioning, adaptive behavior, and educational placement and support have all been demonstrated to improve with early intervention.<sup>1-3</sup> However, most studies of comprehensive, intensive intervention report only immediate outcomes at the end of intervention, and the degree to which these outcomes are sustained over time is largely unknown.<sup>4-6</sup> This is an important question because it is possible that developmental gains achieved with early intervention could diminish after intensive services end. The one long-term outcome study of comprehensive intensive early intervention of which we are aware was published over 20 years ago, and followed 19 children from age 7 to age 11.5 years, all of whom participated in a seminal study of intensive behavioral intervention.<sup>1</sup> Results showed that the intervention group maintained gains in IQ and adaptive behavior, suggesting that intervention effects may be long lasting.<sup>7</sup>

The Early Start Denver Model (ESDM)<sup>8</sup> is a naturalistic behavioral intervention that integrates applied behavior analysis (ABA) methods with developmental approaches and parent coaching designed to promote learning, social reciprocity, and affective engagement. It is designed for children with ASD as young as 12 months of age, can be used in a variety of settings,<sup>9,10</sup> and intervention goals are set within the context of a specified curriculum.<sup>11</sup> In the first randomized clinical trial of the ESDM, children were directly assessed and diagnosed with an autism spectrum disorder at age 18 to 30 months and randomly assigned to either ESDM intervention or to treatment-as-usual in the greater Seattle-area community (Community [COM]). The groups were stratified on sex and developmental quotient. The ESDM group was offered 2-hour intervention sessions twice per day, 5 days per week, for 2 years by trained therapists. The number of hours of therapist-delivered intervention (sum of both individual one-on-one hours and group intervention hours) did not significantly differ between the ESDM and COM groups. Results indicated a positive impact of ESDM on child development across a number of domains, including intellectual ability, particularly in the expressive and receptive language domains, adaptive behavior, and less severe autism diagnosis at the end of intervention.<sup>3</sup> Significant group differences in social behavior at outcome were also found.<sup>12</sup> However, no significant group



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differences in autism symptom levels were found based on direct observation by examiners blinded to intervention group at the end of the study period.

The present study examined whether early intensive behavioral intervention with the ESDM had sustained effects 2 years later in this same cohort of children. This will be the first study, to our knowledge, to examine the role of early intensive behavioral intervention initiated at less than age 30 months in altering the long-term clinical course of ASD. We hypothesized, first, that children who received 2 years of ESDM in the previous RCT would maintain outcomes for 2 years after the end of the intervention study across all key developmental domains including IQ, adaptive behavior, autism symptom levels, challenging behavior, and diagnosis by demonstrating the same or better average levels of age-adjusted performance than at the end of study treatment; and, second, that at age 6, the ESDM group would continue to show greater intellectual ability, adaptive behavior, and social functioning and less severe ASD diagnoses and challenging behavior levels as compared to children receiving treatment as usual, and that the groups would not differ in terms of core autism symptoms and repetitive behavior, consistent with results reported previously immediately after intervention. We further hypothesized that the gains demonstrated immediately after intervention would generalize to peer relationships, a new domain of functioning that is developmentally relevant at age 6 years but was not assessed as part of the original study.

## METHOD

### Participants

A total of 39 children who participated in an RCT of early intensive intervention at the University of Washington were assessed at age 6 years. The original RCT study sample consisted of 48 children diagnosed with an ASD at age 18 to 30 months and randomized into 2 groups (ESDM,  $n = 24$ ; COM,  $n = 24$ ) stratified by developmental quotient and sex. Research diagnosis of ASD at baseline was based on direct assessment by expert clinicians with the Autism Diagnostic Interview-Revised (ADI-R),<sup>13</sup> Autism Diagnostic Observation Schedule-WPS (ADOS-WPS),<sup>14</sup> and clinical judgment using all available information. The ADI-R, a parent interview, and the ADOS-WPS, a semi-structured play observation, are both standardized measures used to diagnose ASD. In addition, information from family history, medical records, cognitive test scores, and clinical observation made during the course of the research assessments were considered when assigning the *DSM-IV-TR* diagnosis (detailed in Dawson *et al.*).<sup>3</sup> The 2 groups did not differ at baseline in severity of autism symptoms, chronological age, IQ, sex, or adaptive behaviors in the original RCT, nor were there baseline group differences for the subgroup of children who completed the 2-year follow-up assessment (all  $p > .05$ ). All children who, at baseline, had a history of issues such as significant sensory or motor impairment, serious traumatic brain injury, major physical anomalies, genetic disorders associated with ASD (e.g., Fragile X syndrome), seizure disorder, or prenatal drug exposure were excluded from this study.<sup>3</sup> This sample was assessed in the previous study at baseline and at 1 and 2 years after randomization, coinciding with the end of ESDM intervention, and long-term follow-up was conducted at age 6 years (hereafter

referred to as baseline, 1-year, 2-year, and age-6 assessments, respectively). Attrition rates were equal across groups over the follow-up period, with 3 participants lost in each group. In the original RCT, from baseline to the end of the intervention period, the ESDM group lost no children, but the COM group lost 3 (ESDM, 1-year  $n = 24$ , 2-year  $n = 24$ , age-6  $n = 21$ ; COM 1-year  $n = 23$ , 2-year  $n = 21$ , age-6  $n = 18$ ). The age-6 follow-up sample was evaluated with the same diagnostic procedures used at the baseline and 2-year assessments.

Data reported for the current study were obtained when participating children were on average 6 years of age (mean = 72.9 months, standard deviation [SD] = 2.6,  $N = 39$ ). In the age-6 sample, 72% were of white ethnicity, with 9 girls and 30 boys (COM = 4 girls, ESDM = 5 girls). Mothers were on average highly educated, with only 13% reporting no college, 23% reporting some college, and 64% reporting college completion. The treatment groups did not differ with regard to maternal education (ESDM: 62% college grad, 28% some college, 10% no college; COM: 70% college grad, 18% some college, 12% no college;  $\chi^2 = 0.63$ ,  $p > .50$ ). Median annual household incomes between the groups also did not differ (ESDM \$90,000, COM \$85,000; Wilcoxon rank sum test,  $W = 152.5$ ,  $p > .50$ ).

Parents were interviewed about their children's service use every 6 months from the end of the intervention study (2-year) to follow-up (age-6). At each interview, parents were asked to characterize the child's use of behavioral health treatments and therapy provided by allied health professionals that had occurred since the last interview. During the follow-up period, the average amount of ABA-based therapy and other therapies (e.g., speech/language, occupational therapy, physical therapy) received were calculated. Roughly 41% of the children (5 of 18 COM and 11 of 21 ESDM children) received no ABA-based therapy during this period. Given the skewed distributions of treatment hours received, group differences were examined with a nonparametric Wilcoxon rank sum test. The ESDM group received fewer ABA-based therapy hours per week (mean = 2.40, SD = 2.97, range 0–8.4) than the COM group (mean = 4.36, SD = 3.56, range 0–11.0); however, this was not significant ( $W = 244.5$ ,  $p = .108$ ). The ESDM group received significantly fewer hours/week of other therapy services (mean = 1.64, SD = 1.73, range 0–6.3) than the COM group (mean = 3.14, SD = 2.33, range 0.6–7.8;  $W = 2.68.0$ ,  $p = .027$ ). Interestingly, for the ESDM group, 41.5% of these therapy hours were in a group setting, whereas only 21.7% of these therapy hours in the COM group occurred in a group setting.

### Procedures

Intellectual ability and autism symptom level were measured at all time points by a licensed clinical psychologist or doctoral students in clinical psychology under the supervision of a licensed clinical psychologist at the University of Washington. The assessors were naive to the intervention status of the children at all assessments. Repetitive behavior, challenging behavior, and adaptive behavior were measured by parent-reported questionnaire at all time points. Peer relationships were measured by parent-reported interview at age 6 years. All study procedures were approved by the University of Washington Institutional Review Board and were conducted with written consent of primary caregivers.

### Measures

**Intellectual Ability.** The Differential Ability Scales (DAS)<sup>15</sup> School Age Level were used to measure intellectual ability at the age-6 assessment. This battery is designed and normed for use with children from ages 2 years 6 months to 17 years 11 months. We report a

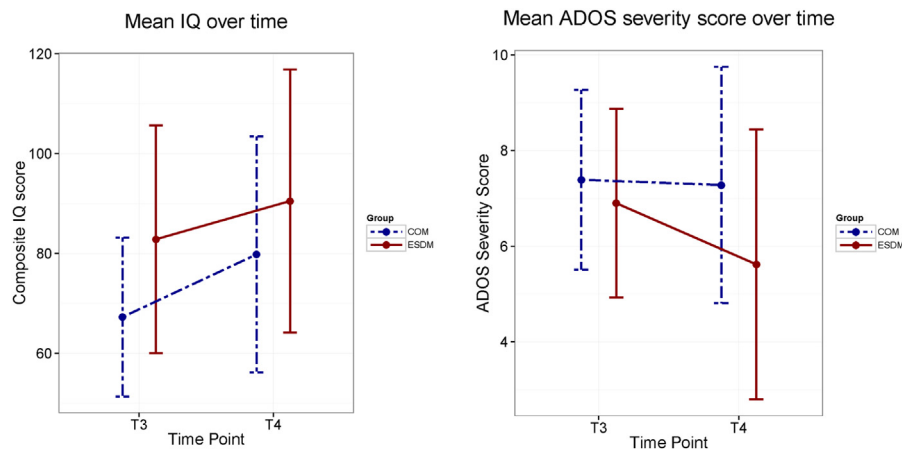
**TABLE 1** Child Outcome Variables: Treatment Group Differences With Time Point as a Repeated Measure

Variable	Time	Community			ESDM			Effect	F	Gen $\eta^2$
		Mean	SD	n	Mean	SD	n			
IQ										
ELC/GCA	T3	67.28	15.91	18	82.86	22.83	21	Time <sup>a</sup>	16.96***	0.049
	T4	79.83	23.64	18	90.52	26.36	21	Tx Group <sup>b</sup>	3.66	0.081
Verbal IQ	T3	68.33	17.75	18	81.76	23.87	21	Tx Group:Time <sup>c</sup>	0.99	0.003
	T4	84.89	20.14	18	91.29	22.52	21	Time	24.03***	0.089
Nonverbal IQ	T3	66.50	15.63	18	83.95	24.15	21	Tx Group	2.45	0.053
	T4	78.72	27.56	18	90.33	26.38	21	Tx Group:Time	1.75	0.007
Vineland										
Adapt Behavior Composite	T3	59.00	9.46	16	69.35	13.94	17	Time	47.46***	0.177
	T4	72.06	13.86	16	81.41	17.27	17	Tx Group	4.77*	0.117
Communication	T3	69.71	15.53	17	83.06	20.61	17	Tx Group:Time	0.08	0.000
	T4	79.71	18.53	17	88.35	19.76	17	Time	11.37**	0.043
Daily Living Skills	T3	58.76	8.67	17	66.06	11.83	17	Tx Group	3.36	0.084
	T4	77.71	16.40	17	83.06	21.56	17	Tx Group:Time	1.08	0.004
Socialization	T3	63.19	8.63	16	70.47	10.34	17	Time	50.03***	0.266
	T4	69.44	13.81	16	79.24	16.03	17	Tx Group	1.86	0.043
ADOS										
Restricted/Repetitive	T3	4.00	2.14	18	3.24	1.79	21	Time	0.75	0.005
	T4	4.17	2.46	18	2.48	1.97	21	Tx Group	4.54*	0.083
Social Affect	T3	12.94	4.04	18	11.24	4.00	21	Tx Group:Time	1.84	0.013
	T4	11.83	4.85	18	8.76	5.47	21	Time	6.66*	0.038
Total	T3	16.94	4.50	18	14.48	5.31	21	Tx Group	3.28	0.065
	T4	16.00	6.57	18	11.24	6.87	21	Tx Group:Time	0.96	0.006
ABC										
Hyperactivity	T3	16.40	10.03	15	13.00	8.46	17	Time	0.24	0.002
	T4	17.07	9.56	15	13.76	9.33	17	Tx Group	1.28	0.033
Irritability	T3	10.87	8.96	15	7.12	6.46	17	Tx Group:Time	0.00	0.000
	T4	12.13	10.42	15	6.47	6.67	17	Time	0.05	0.000
RBS										
Total score	T3	21.94	14.60	17	16.53	13.95	17	Tx Group	3.35	0.081
	T4	26.76	17.65	17	17.35	12.84	17	Tx Group:Time	0.51	0.004
<p>Note: ABC = Adaptive Behavior Composite; ADOS = Autism Diagnostic Observation Schedule; ELC = Early Learning Composite; ESDM = Early Start Denver Model; GCA = General Conceptual Ability; Gen = generalized; RBS = Repetitive Behavior Scale; Tx = treatment.</p> <p><sup>a</sup>Time = main effect for time point.  <sup>b</sup>Tx Group = main effect for treatment group.  <sup>c</sup>Tx Group:Time = treatment group-by-time point interaction.  *<math>p &lt; .05</math>; **<math>p &lt; .01</math>; ***<math>p &lt; .001</math>.</p>										

General Conceptual Ability (GCA) score reflecting conceptual and reasoning ability and cluster scores measuring verbal and nonverbal skill areas.

The Mullen Scales of Early Learning (Mullen)<sup>16</sup> were used at baseline and 2-year assessments. This battery is a standardized developmental test for children ages birth to 68 months.

**FIGURE 1** IQ and Autism Diagnostic Observation Schedule (ADOS) severity by group and time point. Note: Error bars  $\pm 1$  standard deviation. COM = community; ESDM = Early Start Denver Model.



Standardized *t* scores from 4 subscales (Fine Motor, Visual Reception, Expressive Language, Receptive Language) and standard score from the Early Learning Composite (ELC) were assessed at the end of intervention (2-year assessment).

**Adaptive Behavior.** The Vineland Scales of Adaptive Behavior (VABS)<sup>17</sup> are a parent interview assessing social, communication, motor, and daily living skills with standard scores based on a large normative sample. We reported overall (Adaptive Behavior Composite [ABC]) and subdomain (Socialization, Communication, Daily Living Skills) standard scores at 2-year and age-6 assessments.

**Autism Symptoms.** The ADOS-WPS version<sup>14</sup> is a semistructured, standardized interaction and observation tool that measures autism symptoms in social relatedness, communication, play, and repetitive behaviors. At age 6 years, ADOS Total, Social Affect, Repetitive Behavior, and Severity scores are reported.<sup>18</sup> The assessment tool was administered at baseline, 2-year, and age-6 assessments.

The Repetitive Behavior Scale-Revised (RBS-R)<sup>19</sup> is a parent questionnaire involving 43 items that characterize severity of repetitive behavior in ASD. It yields 6 domain scores (e.g., sameness, self-injurious behavior) and a total score. It was administered at the age-6 assessment and has been validated for use with children with ASD.<sup>20</sup>

**Challenging Behaviors.** The Aberrant Behavior Checklist (ABC)<sup>21</sup> is a reliable and valid 58-item measure of challenging behaviors known to occur in individuals with moderate to profound developmental disability. The scales were empirically derived by factor analysis. The following scales were used as measures of challenging behavior in this study: irritability (irritability, agitation, crying), and hyperactivity (hyperactivity, noncompliance). The child's primary caregiver, usually the mother, completed this questionnaire at 2-year and age-6 assessments.

**Peer Relationships.** The ADI-R<sup>13</sup> is a semi-structured parent interview that assesses autism symptoms across 3 domains: social relatedness, communication, and repetitive behaviors. The mean of current behavior scores on items 61 to 65 (Imitative social play, Interest in children, Response to approach of other children, Group play with peers, Friendships) was used to assess peer relations on a scale from 0 (no concerns) to 3 (serious concerns).

## Data Analysis

To examine the children's long-term course of development after intervention, repeated-measures analyses of variance were

conducted,<sup>22</sup> with treatment group as a between-subjects factor and time point as a within-subjects factor. The results, along with effect sizes calculated<sup>23,24</sup> using generalized  $\eta^2$ , are presented in Table 1. Group differences in peer relations between the ESDM and COM group at age-6 were assessed using 1-tailed *t* tests to evaluate whether the ESDM showed improved functioning over the COM group.

## RESULTS

### Developmental Outcomes After Early Intervention

For all IQ and Vineland domains, there was a significant main effect of time, demonstrating continued improvement in intellectual and adaptive functioning for both treatment groups. There were no significant treatment group effects or a treatment group-by-time interaction for the IQ variables. The ESDM group's composite and nonverbal IQ scores remained 10 points higher at age-6; however, the treatment group effect fell short of significance ( $p = .063$  and  $.051$ , respectively). A nonsignificant verbal IQ advantage of 6.4 for the ESDM group was observed (Figure 1).

Standard scores on the Vineland remained 5 to 10 points higher for the ESDM group at age-6. Significant group effects were present for the Vineland Adaptive Behavior Composite and Socialization scores. No significant group-by-time interactions were observed.

### Core Symptom Outcomes After Early Intervention

Significant treatment group effects were seen on ADOS Total and Restricted and Repetitive Behavior scores as the ESDM group showed lower overall scores. The ESDM group also had lower Social Affect scores; however, this difference fell short of significance ( $p = .078$ ). There were significant time effects on the Social Affect and Total scores, as overall age-6 scores were lower than those at age-4. There were no significant group-by-time interactions on any of the ADOS variables (Figure 1).

Scores on the RBS were similar between the 2-year and age-6 assessments for both groups, with no significant effect

of time. The Composite score was not significantly different between groups. The group-by-time interaction term was not significant.

### Diagnostic Outcomes After Early Intervention

There was no statistically significant difference in diagnostic categorization in the 2 groups at age-6 (Fisher exact probability test;  $p = .27$ ; ESDM 57%,  $n = 12$  Autistic Disorder, 33%  $n = 7$  PDD, 10%,  $n = 2$  no diagnosis; COM 78%  $n = 14$  Autistic Disorder, 22%  $n = 4$  PDD). The 2 children in the ESDM group were classified as “no diagnosis” according to the clinical judgment of 2 expert clinicians blind to prior intervention group at age-6. At age-6, these 2 children obtained composite IQ scores of 92 and 110 and ADOS module 3 calibrated severity scores of 2 and 1, well short of the symptom levels for ASD classification. One child received an average of 4.50 hours per week of 1:1 ABA therapy and 0.32 hours per week of other group-based treatment between study completion and the age-6 follow-up assessment, with all education hours occurring in general education contexts. The second child received an average of 0.13 of other (non-ABA) treatment between study completion and the age-6 follow-up assessment, with 58% of educational hours occurring in a general education context and 42% in special education.

### Challenging Behavior Outcomes

The Irritability and Hyperactivity subdomain scores were not significantly different, and there were no significant time effects or any group-by-time interactions.

### Peer Relationship Outcomes

We hypothesized that the gains demonstrated immediately after intervention would generalize to improved peer relationships at age 6 years. There was a nonsignificant trend for the ESDM group to have more positive peer relationships than the COM group (COM mean = 1.37, SD = 0.60; ESDM mean = 1.03, SD = 0.57;  $t = 1.84$ ,  $p = .0741$ , ES = 0.57).

## DISCUSSION

The current study prospectively examined evidence for the sustained effects of early intensive behavioral intervention initiated between 18 and 30 months of age for children with ASD at age 6. Children in the ESDM group maintained the gains that they had made in early intervention 2 years later in all areas, including intellectual ability, adaptive behavior, autism symptoms, and challenging behaviors. This provides direct evidence that these children did not exhibit a developmental regression, lose skills, or, in the case of standardized tests, slow their rate of development after withdrawal of early intensive services. Furthermore, at age 6, in comparison to the COM group, the ESDM group demonstrated better adaptive behavior and socialization ability and less severe overall ASD symptoms. The reduction in ASD symptom severity, revealed in direct assessments conducted by expert clinicians naive to intervention group (ADOS total

and repetitive behavior) and parent report of improved socialization (VABS-II), was striking. We did not hypothesize that this would be the case at age 6 because the ESDM group did not demonstrate this advantage at the end of the original RCT at age 4. Two children in the ESDM group, but not the COM group, no longer met criteria for ASD according to 2 expert clinicians naive to intervention group. The ESDM group demonstrated a nonsignificant trend toward better peer relations, a new domain of functioning assessed at age 6, compared to the COM group. Although both the ESDM and COM groups showed improvements in intellectual ability across the follow-up period, there were no longer significant group differences at age 6, contrary to our hypothesis. This is the first report of long-term outcomes of a comprehensive intervention begun before 30 months of age in children with ASD, and demonstrates continued positive impacts on development. Two years later, these children maintained the gains achieved over the course of the intervention period, and long-term outcome data revealed improvement during follow-up in the ESDM group compared with the COM group in areas not seen at the end of the original RCT.

This convergence of evidence, from both parents and clinicians naive to intervention group, suggests the possibility that the significant IQ, language, and social ability gains made by the end of the early intervention period were not just maintained, but had generalized to new areas of functioning. This was particularly notable because core ASD symptoms are one of the most difficult areas for demonstrating improvement. If replicated, these results could suggest a particular benefit of ESDM relative to other intervention options. It was also notable that group differences in intellectual ability seen at the end of early intervention were no longer present at age 6. Both groups increased standardized intellectual ability scores over the follow-up period, with the COM group increasing 12.55 points and the ESDM group increasing 7.66 points. Thus, the lack of statistically significant group differences was due to variability (i.e., large standard deviations in scores) and a larger mean increase in scores in the COM group rather than a loss of skills in the ESDM group.

The observed developmental gains in intellectual ability for both groups and the decreased symptom severity for the ESDM group occurred in the context of community intervention and educational services. During the follow-up period, we assessed the number of hours of intervention that parents spontaneously sought for their children after completion of the RCT. The ESDM and COM groups significantly differed in the number of hours of ABA-based and other intervention that they received. Parents of children in the ESDM group reported a reduction in one-on-one intervention hours from 15.2 hours per week during the study period to 4.04 hours per week during the follow-up period. Parents of children in the COM group reported one-on-one intervention hours were reduced from 9.1 hours per week during the study period to 7.5 hours per week during follow-up. The ESDM group increased their performance during a period of substantially reduced one-on-one services, suggesting that they

may have increased their ability to learn from less restrictive, more naturalistic environments as a result of early intervention.

It is important to consider characteristics of this study that may limit the generalizability of these findings. The COM group received a number of intervention hours similar to that of the ESDM group during the initial study period. Although this was a strength of the study in terms of making valid group comparisons, it may suggest that the COM group had greater access to intervention than is typical. One effect of enrollment was that each family received early diagnosis and referrals to community services by a team of expert clinicians. In addition, this sample was recruited from a geographically constrained area, 30 minutes from an urban university. This was necessary for the university-based intervention team to be able to carry out high-intensity, in-home services without incurring extraordinary transportation expenses. However, this meant that families from the COM group lived in close proximity to a number of excellent private intervention providers. Families that participated in this longitudinal study may differ from other families who did not participate in terms of ability and motivation to obtain high levels of early behavioral intervention for their children. We also observed high numbers of intervention hours in the comparison group from an RCT of a low-intensity, parent coaching intervention that we conducted with a different sample.<sup>25</sup> In that study, the groups had received equivalent intervention hours up until randomization. However, in a very short time, by the end of the 12-week intervention period, there was a significant difference in the number of treatment hours that children (aged 12 to 24 months) were receiving weekly, with the comparison group receiving more intervention (mean P-ESDM = 1.48; [SD = 1.96]; mean community group = 3.68 [SD = 3.91],  $p < .05$ .) It is possible that families who enroll in an RCT and are randomized to the control group might make even more effort to obtain intervention when they are not assigned to the intervention group. Thus, participating families, even those who are randomized to community intervention, may receive more and earlier intervention than other families in the same community.

Mothers in this study were on average highly educated, with only 13% reporting no college, 23% reporting some college, and 64% reporting college completion. In contrast, educational attainment among US women nationally is estimated as 32% with no college, 33.6% with some college, and 34.5% with college completion or higher.<sup>26</sup> Importantly for the purposes of this efficacy study, the 2 groups (ESDM and COM) had equivalent maternal education levels and were comparable to other groups of mothers who participate in research on child development at this university.<sup>27</sup> However, there is a critical need to evaluate the effectiveness of this and other early autism intervention programs in culturally diverse populations, less-educated families, and lower resource, rural, or military communities.

Measurement issues may also constrain the types of observations that we are able to make. For example, our

measure of symptom severity, the ADOS, has 4 different modules based on the verbal ability of the participant, ranging from Module 1 for nonverbal individuals to Module 4 for highly verbal adults. These modules contain a number of different activities and reflect qualitative differences in the expectations for a nonverbal individual as compared with individuals with more advanced communication abilities. Thus, individuals who have better verbal abilities have to meet higher expectations for social interaction. Thus, differences in symptom severity as measured by the ADOS should be interpreted cautiously.

This is a follow-up to a randomized trial of a manualized intervention with measured fidelity to the intervention model, clearly described inclusion criteria, well-matched groups before randomization, and assessment by clinicians who were naive to intervention group. Attrition during the follow-up period was minimal and balanced across groups (3 in each), but should be noted. An inherent weakness in the community intervention-as-usual study design is the impossibility of adequately describing and quantifying the intervention received in community settings. This difficulty is amplified in the follow-up study period when children in both groups receive non-randomly assigned intervention of differing types and intensities. Although we carefully assessed the hours of intervention and general categories of intervention received, we were not able to create a single metric to directly compare community-delivered interventions because of unmeasured differences in implementation and practices. Thus, the impact of intervention received after the study period is unknown. However, we can observe that the comparison group in the present study appeared to have more positive outcomes than the comparison group in the only other long-term follow-up study of a comprehensive, intensive intervention.<sup>7</sup> It is not unreasonable to speculate that one contributor to the positive outcomes in the COM group that we report here is the availability and high quality of intervention in the greater Seattle area. We suspect that services for individuals with autism have greatly improved across many communities in the 20 years since the first long-term follow-up study<sup>7</sup> was conducted. Future studies are needed to replicate these findings in independent samples, to extend these findings to individuals of older ages, and to investigate other styles and approaches to intervention.

These results demonstrate that significant, longer-term gains are possible with early, comprehensive, intensive intervention, and that these gains are evident not only in intellectual ability, language, and social behavior, but also in reductions in ASD symptoms. In 2 cases, children who received ESDM no longer met criteria for an ASD diagnosis. This study replicates the results of McEachin *et al.*<sup>7</sup> but also extends those findings to intervention begun with children less than 30 months of age and provided at less than half the number of hours per week, in a developmental style of delivery. A recent cost-comparison study of early intensive behavioral intervention in the Netherlands suggests that lifetime cost savings could be

more than 1 million Euros per individual.<sup>28</sup> These findings demonstrate how early identification and intensive, early, ASD-specific intervention can improve long-term outcomes for children with ASD; they also suggest the need to extend this work into lower-resourced community settings to work toward improving outcomes for all children with ASD &



### Clinical Guidance

- Early intensive behavioral intervention has been found to be efficacious in improving developmental outcomes for young children with autism spectrum disorder.
- Children were able to maintain the developmental gains that they made in early, intensive, in-home intervention over a 2-year follow-up period. These children did not exhibit developmental regression or lose skills, even after substantial reductions in services.
- Intellectual, language, and adaptive functioning gains made as a result of early intervention may generalize to new domains of functioning, such as reduced ASD symptom severity, 2 years later.
- Research is needed to extend these results to a more diverse range of families and communities to assess the effectiveness of early autism intervention.

Accepted April 24, 2015.

Drs. Estes, Munson, and Greenson are with University of Washington Autism Center and University of Washington, Seattle. Dr. Rogers is with University of California, Davis. Dr. Winter is with Weill-Cornell Medical College, New York City. Dr. Dawson is with Duke University, Durham, NC.

This research was supported by grants from the National Institute of Mental Health, the National Institute of Child Health and Human Development (U19HD34565, P50HD066782, R01HD-55741), and the National Institute of Mental Health (U54MHO66399).

Dr. Munson served as the statistical expert for this research.

The authors thank the children and parents who participated in this study and Lena Tsui, MS, of the University of Washington Autism Center, for her devotion to keeping in touch with these children and parents.

Disclosure: Dr. Estes has received grant or research funding from the Simons Foundation, the National Institutes of Health, the National Institute of Mental Health, and the Autism Speaks Foundation. Dr. Rogers has received royalty payments and material fees related to the Early Start Denver Model (ESDM). She has also received occasional honoraria from Guilford Press for ESDM materials. She is a co-author of two books on early intervention: *The Early Start Denver Model for Young Children With Autism: Promoting Language, Learning, and Engagement* and *An Early Start for Your Child With Autism*, from which she has received royalties (Guilford Press). Dr. Dawson is a co-author of two books on early intervention: *The Early Start Denver Model for Young Children With Autism: Promoting Language, Learning, and Engagement* and *An Early Start for Your Child With Autism*, from which she has received royalties (Guilford Press). Drs. Munson, Greenson, and Winter report no biomedical financial interests or potential conflicts of interest.

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<http://dx.doi.org/10.1016/j.jaac.2015.04.005>

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