

Intervention for Optimal Outcome in Children and Adolescents with a History of Autism

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ABSTRACT: *Objective:* Autism spectrum disorders (ASDs) were once considered lifelong disorders, but recent findings indicate that some children with ASDs no longer meet diagnostic criteria for any ASD and reach normal cognitive function. These children are considered to have achieved “optimal outcomes” (OO). The present study aimed to retrospectively examine group differences in the intervention history of children and adolescents with OO and those with high-functioning autism (HFA). *Method:* The current study examined intervention histories in 25 individuals with OO and 34 individuals with HFA (current age, 8–21 years), who did not differ on age, sex, nonverbal intelligence, or family income. Intervention history was collected through detailed parent questionnaires. *Results:* Children in the OO group had earlier parental concern, received earlier referrals to specialists, and had earlier and more intensive intervention than those in the HFA group. Substantially more children with OO than HFA received applied behavior analysis (ABA) therapy, although for children who received ABA, the intensity did not differ between the groups. Children in the HFA group were more likely to have received medication, especially antipsychotics and antidepressants. There were no group differences in the percent of children receiving special diets or supplements. *Conclusion:* These data suggest that OO individuals generally receive earlier, more intense interventions, and more ABA, whereas HFA individuals receive more pharmacologic treatments. Although the use of retrospective data is a clear limitation to the current study, the substantial differences in the reported provision of early intervention, and ABA in particular, is highly suggestive and should be replicated in prospective studies.

(*J Dev Behav Pediatr* 35:247–256, 2014) **Index terms:** autism spectrum disorder, optimal outcomes, intervention history, medication.

Autism spectrum disorders (ASDs) are generally considered lifelong disorders. However, some studies have described the phenomenon of “optimal outcome” (OO), in which individuals lose their ASD diagnosis. In 1987, Lovaas¹ first defined “recovery” in autism as achieving success in a regular classroom with average intelligence (IQ) scores but did not determine whether autism symptoms had completely resolved. Mundy² pointed out that these criteria do not by themselves constitute “recovery” because some individuals with high-functioning autism (HFA) may reach this outcome while still showing significant autism symptoms. Subsequent studies have defined OO more stringently and proposed a definition requiring a well-documented history of ASD, no current criteria for ASD, and having both IQ and adaptive functioning within the average range.³ One of the most important questions about this group of

OO individuals is whether their intervention histories differ from those of individuals with HFA.

There are several comprehensive treatment approaches for autism, including applied behavior analysis (ABA),¹ Early Start Denver Model (ESDM),⁴ and Floortime.⁵ In addition, many children receive ancillary therapies, such as speech-language therapy, occupational therapy, and physical therapy.

Generally, ABA is considered the autism intervention supported by the most evidence.⁶ In the study by Lovaas,¹ 47% of children with autism who received intensive ABA met his criteria for “recovery,” compared with only 2% in the less intensive control group,¹ and their gains were maintained.⁷ These studies have been criticized on methodological grounds (e.g., different pre- and postintervention measures, nonrandom assignments, and inadequate control groups) and, as mentioned above, the lack of outcome measures for core symptoms.^{8,9} Attempts at replication have yielded mixed results; while studies have been consistent in supporting intensive ABA, most outcomes have not been as positive as those reported by Lovaas.^{10–12}

Fewer studies of comprehensive treatment approaches other than ABA have been published. Dawson et al⁴ examined the effectiveness of the ESDM, an intervention approach in which behavioral techniques are integrated into a developmental framework, and found that children

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who received the ESDM displayed significantly larger IQ and adaptive functioning gains compared with those who received standard community treatment. In addition, to date, no controlled study for other early intervention approaches have reported outcomes of “recovery,” as was found for some children receiving ABA.

In addition to the studies by Lovaas,¹ Gabriels et al¹³ examined the intensity of behavioral intervention and subsequent gains in young children with autism and found that the “high-outcome” group received an average of 40.3 more treatment hours per month and an average of 1073 more total treatment hours than the “low-outcome” group. While this difference was not statistically significant, power was low and effect sizes were moderate, suggesting that these differences might still be meaningful. Luiselli et al¹⁴ also found that the number of months of treatment was related to improvements in language, cognitive, and socioemotional functioning. On the other hand, several other studies have found no meaningful relationship between the number of intervention hours and cognitive and behavioral gains.^{14,15}

There are several complicating factors in the relationship between treatment intensity and outcome. First, intervention is generally measured in terms of quantity rather than quality. It may be that both quantity and quality make independent contributions to outcome or that the effect of quantity is moderated by quality. Quality is particularly difficult to judge from retrospective reports. Second, children who make slower progress or are more impaired may receive more intensive treatment as a consequence, making interpretation of the relationship between progress and treatment intensity complex.³

While medical treatment is typically considered an adjunctive therapy, many children with autism do receive pharmacologic treatments (i.e., prescribed psychotropic medications).¹⁶ In general, medications are more useful in the treatment of ancillary symptoms, such as irritability, aggression, hyperactivity, poor sleep, and poor attention, than in treating core symptoms.¹⁶⁻¹⁸

Some children with autism also receive complementary-alternative medicine (CAM) treatments, including dietary supplements, modified diets, neurofeedback, chelation, and hyperbaric oxygen.^{16,19} Other than the use of melatonin for sleep, there is no clear evidence that any of these CAM treatments are efficacious for core or secondary symptoms of autism.^{16,19}

Although prospective, randomized, controlled trials would be the most methodologically sound way to compare the number of children reaching “optimal outcome” across treatments, such randomization would be fraught with practical and ethical issues; furthermore, the small percent of children likely to reach “optimal outcome” would make the initial sample needed prohibitively large. We, therefore, used a sample of OO children and adolescents and collected retrospective reports of their therapies at different ages.

The current study uses the sample described by Fein et al,²⁰ which examined a group of OO children and

adolescents between 8 and 21 years and compared them to children and adolescents with HFA and typical development (TD). The authors found that the OO participants did not differ from the TD participants on summary measures of socialization, communication, face recognition, most language subscales, or any academic measure, including reading comprehension and written expression.²¹ A small number of the OO children continued to show some difficulty on components of executive function.²² To date, no one has obtained intervention histories for a group of OO children.

Thus, the aim of the present study was to retrospectively examine the intervention history of the OO and HFA individuals to determine if intervention differences may have contributed to their outcomes. The unique aspect of this study is having a group of OO children and adolescents who have clearly lost their autism diagnosis and are functioning essentially identically to their typically developing peers. Based on the previous literature, we hypothesized that a greater percent of the OO group than the HFA group would have received ABA and that the OO group would have received earlier and more intensive intervention than the HFA group. We did not have an a priori hypothesis about other interventions because these have not been linked to optimal outcome in other studies.

METHODS

Participants

Participants in the current study were taken from the study by the Fein et al,²⁰ which included 34 participants who achieved optimal outcomes (OO) and 44 participants with high-functioning autism (HFA). The current article included the subset of those participants with relatively complete intervention data, which resulted in 25 OO participants and 34 HFA participants. Age of the participants ranged from 8 to 21 years. Groups did not differ on age (mean [HFA] = 14.0 years; mean [OO] = 12.7 years; $t = 1.70$; $p = .095$), gender (male-female ratio: HFA = 31:3 and OO = 20:5; $\chi^2[1, n = 59] = 1.54$; $p = .22$), and nonverbal intelligence (IQ) (mean [HFA] = 110.1; mean [OO] = 109.8; $t = 0.075$; $p = .94$) but were significantly different on verbal IQ (mean [HFA] = 104.4; mean [OO] = 114.4; $t = 2.76$; $p = .008$). Participants tested at the University of Connecticut were primarily from Connecticut or Massachusetts. However, 10 participants in the HFA group and 13 participants in the OO group tested at the University of Connecticut were from other states (AZ, CO, DC, FL, ME, MI, MN, NH, NJ, NY, and UT) or from Canada. Because early intervention varies significantly by region, statistical analyses were conducted with the entire sample and then with the subset of the sample from Connecticut or Massachusetts (24 HFA and 12 OO participants), which have similar early intervention practices, in order to best equate opportunities based on location. Participants were mostly white, with 3 OO and 2 HFA individuals reporting other

ances or ethnicities. Families were generally of middle and high incomes, with 13 of 30 HFA families (43%) earning under \$100,000 per year and 17 earning more than \$100,000. For the OO group, 10 of 24 (42%) earned under \$100,000 and 14 more than \$100,000. Dividing up the income groups in several different ways resulted in no significant Fisher's exact test or χ^2 values. However, it should be noted that 3 families in the HFA group reported annual incomes of \$30,000 or less, compared with none in the OO group, so it is possible that, with larger groups, there would have been lower socioeconomic status for the HFA group. Educational placement information was available for 29 of the 34 HFA participants. Of these participants, 41% were mainstreamed, 10% were mainstreamed with a 1:1 aide, 28% were mainstreamed with some pullout for academics, and 21% were in self-contained classrooms.

Recruitment was done through media outlets (newspaper stories, radio interviews), private practices, word of mouth between participant families, and clinic referrals. Participants were also referred from the principal investigators' private practices, the Psychological Services Clinic at the University of Connecticut, and other ongoing studies at the University of Connecticut. The study was approved by the Institutional Review Boards at the University of Connecticut, the Institute of Living of Hartford Hospital, and Queens University (see Fein et al²⁰ for a flow chart of participant inclusion and exclusion).

Inclusion Criteria

All participants had verbal, nonverbal, and full-scale IQ standard scores greater than 77 (within 1.5 SD of the average of 100). Additional OO criteria were as follows:

1. Participants had an autism spectrum disorders (ASD) diagnosis before 5 years of age by a physician or psychologist specializing in autism, in a written report, with documented early language delay (no words by 18 months or no phrases by 24 months). To confirm diagnosis, the report was edited to remove information about diagnosis, summary, and recommendations but leaving descriptions of behavior. One of the coinvestigators (M.L.B.), an expert in the diagnosis of ASD and director of the University of Connecticut Psychological Services Clinic reviewed these reports, blind to early diagnosis and current group membership. In addition to potential OO participants, she reviewed 24 "foil" reports for children with non-ASD diagnoses, such as global delay or language disorder. Four potential OO participants were rejected for insufficient early documentation and were excluded from the study. All 24 foils were correctly rejected.
2. On phone screening, parents had to report that the participant had typically developing friends. During evaluation, participants could not meet criteria for any ASD on the Autism Diagnostic Observation Schedule (ADOS)²³ administered by a research-reliable

interviewer. In addition, the ADOS videotapes of all potential OO cases were reviewed by a clinician with more than 15 years of autism diagnostic experience (M.L.B., I.-M.E., or D.A.F.) who confirmed that ADOS scores were below ASD thresholds and that in their expert clinical judgment, an ASD was not present. Five potential OO participants were judged to have social impairments with an autistic quality and were excluded.

3. Communication and socialization domains of the Vineland Adaptive Behavior Scales²⁴ had to be greater than 77 (within 1.5 SDs of the mean of 100).
4. Participants had to be fully included in regular education classrooms with no one-on-one assistance and no special education services to address autism deficits (e.g., no social skills training). However, participants could be receiving limited special education services or psychological support to address impairments not specific to ASDs, such as attention or academic difficulties.

To be included in the HFA group, the criteria are as follows:

Following Collaborative Programs of Excellence in Autism guidelines,²⁵ participants had to meet criteria for ASD on the ADOS (both social and communication domains and total score) and according to best estimate clinical judgment. Based on the ADOS, 19 participants in the HFA group were classified as having an ASD and 15 participants in the HFA group were classified as having Autistic Disorder.

Exclusion Criteria

Potential participants for any group were excluded if (1) at the time of telephone screening, they exhibited major psychopathology (e.g., active psychotic disorder) that would impede full participation, (2) they had severe visual or hearing impairments, or (3) they had a seizure disorder, fragile X syndrome, or head trauma with loss of consciousness. Two in the HFA group were excluded because of possible seizure disorder; none were excluded for other reasons.

Procedure

Potential participants who passed telephone screening were scheduled for an assessment. For participants younger than 18 years, parent consent and child assent were obtained prior to testing. For participants who were 18 years and older, informed consent was obtained. Intervention history was obtained through questionnaires completed by parents.

Measures

The Wechsler Abbreviated Scale of Intelligence²⁶ was used to assess verbal and nonverbal cognitive abilities. The Vineland Adaptive Behavior Scales²⁴ assessed communication and socialization skills. Module 3 or 4 of the ADOS,²³ a structured play and interview session, was used to assess symptoms of autism. The Autism Diagnostic Interview,

Revised²⁷ and the lifetime version of the Social Communication Questionnaire²⁸ were used to determine childhood symptom severity and age of first concerns.

Parents reported the specific type of intervention and hours per week for the following age periods: before 1.5 years, 1.5 to 2 years, 2 to 2.5 years, 2.5 to 3 years, first year of preschool (age, 3–4 years), and second year of preschool (age, 4–5 years). For each interval, parents were asked to indicate which of the following services the child received: applied behavior analysis, developmental therapy (including Floortime), speech-language therapy, occupational therapy, special education class/special school, and sensory integration therapy. The form also asked about current and previous medications, nutritional supplements, and special diets.

RESULTS

Early Symptom Severity/Age of First Concerns

The lifetime Social Communication Questionnaire was used to examine autism symptom severity in early childhood. Both groups scored above the autism cutoff; however, symptom severity was greater in the high-functioning autism (HFA) group (mean [HFA] = 22.4; mean of optimal outcome [OO] group = 16.0; $t = 3.85$; $p < .001$). On the Autism Diagnostic Interview, Revised (ADI-R), parents in the OO group reported a somewhat earlier age of first concern about their child's development than those in the HFA group (mean [HFA] = 22.0 months; mean [OO] = 16.7 months; $t = 2.00$; $p = .052$). Still, both groups reported early concerns, as shown by mean ages before the second birthday. On the ADI-R, the interviewer's judgment of age when developmental abnormalities first manifested did not differ between the groups (mean [HFA] = 15.1 months; mean [OO] = 15.4 months; $t = 0.16$; $p = .87$). This suggests that the age of onset of symptoms did not differ between the groups but that parents became concerned about 5 months later on average in the HFA group. The age at which children were reported to have been referred to a specialist (behavioral specialist, developmental pediatrician, geneticist, neurologist, psychiatrist, psychologist, or speech/language pathologist) because of concerns about development was later in the HFA than in the OO group (mean [HFA] = 43.9 months; mean [OO] = 26.1 months; $t = 3.79$; $p = .001$). The 3 low-socioeconomic status families of HFA children had an average age of first concern of 23 months, very similar to the HFA group as a whole.

Behavioral/Developmental Interventions

Significantly more participants in the OO group (83%) received birth-to-3 services compared to those in the HFA group (48%) ($\chi^2[1, n = 56] = 6.73$; $p = .009$; Cramer's $V = .35$). Similarly, significantly more participants in the OO group (92%) attended preschool than those in the HFA group (56%) ($\chi^2[1, n = 58] = 8.70$; $p = .003$; Cramer's $V = .39$).

Six HFA participants were missing some intervention data, which is reflected in Tables 1 and 2. As shown in Table 1, very few participants in either group received any intervention prior to 1.5 years. The percentage of children receiving intervention in each group increased continuously with age, except for a decrease in the HFA group during the second year of preschool. Significantly more children in the OO group received intervention between 2.5 and 3 years and between 4 and 5 years, with small-medium effect sizes and with a trend at the 2 to 2.5 years of age. A similar pattern held for the subset of the sample from Connecticut and Massachusetts, although because of the smaller sample size, the only significant difference was for the 4 to 5 age period.

The frequencies of the different types of intervention received for each age period are shown in Table 2. Data were not examined before 1.5 years of age because a few participants received intervention then.

Between 1.5 and 2 years, there was one significant difference, showing a higher frequency of developmental therapy in the OO group than the HFA group (16 vs 0%), with a small effect. About one third of participants in both the groups were receiving speech-language therapy. Other interventions were infrequent in both the groups.

Between 2 and 2.5 years, significantly more participants in the OO group (20%) were receiving developmental therapy, compared to the HFA group (0%). In addition, significantly more OO participants (40%) than HFA participants (4%) received applied behavior analysis (ABA), a group difference with a medium effect size. The group difference in ABA was also present between 2.5 and 3 years, with a medium effect size (OO, 56%; HFA, 7%).

The pattern persisted during the first year of preschool (age, 3–4 years), with significantly more children in the OO group (60%) than in the HFA group (32%) receiving ABA, with a small effect size, and during the second year of preschool (age, 4–5 years) (OO group, 72%; HFA group, 25%), with a medium effect size. See Figure 1 for group differences in ABA frequency over time. In addition, there was a small effect of more participants in the OO group (72%) receiving occupational therapy than in the HFA group (36%) during the second year of preschool.

Similar results for frequency of intervention type across the groups were found for the subset of children from Connecticut and Massachusetts, although with fewer significant items, presumably because of the smaller sample size.

We also examined contrasts between the groups for the number of weekly therapy hours (see Table 1). The OO group received significantly more intervention hours per week than the HFA group in both 6-month periods between the second and third birthdays. There were no group differences in the number of intervention hours prior to 2 years of age; however, very few children in either group received any intervention at that age. Although not statistically significant, for the first and

Table 1. Percent of Participants Who Received Any Type of Intervention and Mean Number of Weekly Intervention Hours, By Age

| Frequency of Participants Receiving Intervention | | | | | | | | | | |
|--|--------------------|--|--|-------------------|-------------|----------|-------------------------------|--|--|--|
| Age, yr | HFA; N = 28, n (%) | | | OO; N = 25, n (%) | Chi-Square | <i>p</i> | Effect Size <i>Cramer's V</i> | | | |
| Before 1.5 | 1 (4) | | | 3 (12) | .25 | | .16 | | | |
| 1.5–2 | 11 (39) | | | 9 (36) | .81 | | .034 | | | |
| 2–2.5 | 12 (43) | | | 17 (68) | .066 | | .25 | | | |
| 2.5–3 | 17 (61) | | | 22 (88) | .025 | | .31 | | | |
| First year of preschool (3–4) | 24 (86) | | | 22 (88) | .81 | | .034 | | | |
| Second year of preschool (4–5) | 19 (68) | | | 23 (92) | .031 | | .30 | | | |

| Mean Number of Weekly Intervention Hours | | | | | | | | | | |
|--|-----------|-------|--------------------|----|----------|------|--------------------|----|-------------|------------------|
| Age, yr | HFA Group | | | | OO Group | | | | <i>p</i> | Cohen's <i>d</i> |
| | Mean | SD | Range ^a | n | Mean | SD | Range ^a | n | | |
| Before 1.5 | 4.0 | No SD | No range | 1 | 5.3 | 4.2 | 2–10 | 3 | .81 | –0.44 |
| Between 1.5 and 2 | 9.4 | 15.3 | 0.5–49 | 9 | 7.1 | 6.4 | 1–17 | 9 | .69 | 0.20 |
| Between 2 and 2.5 | 4.1 | 4.0 | 0.5–13 | 8 | 14.8 | 12.8 | 1–42 | 16 | .006 | –1.13 |
| Between 2.5 and 3 | 7.3 | 9.5 | 0.25–28 | 14 | 21.1 | 16.9 | 1–52 | 20 | .005 | –1.01 |
| First year of preschool (3–4) | 15.4 | 15.1 | 1–40.5 | 19 | 24.2 | 15.5 | 1–51 | 21 | .076 | –0.58 |
| Second year of preschool (4–5) | 18.9 | 17.0 | 0.5–47 | 17 | 25.8 | 14.3 | 1.5–60 | 22 | .17 | –0.44 |

^aMeans, SDs, and ranges only include participants who received some intervention. HFA, high-functioning autism; OO, optimal outcome. Significant values are indicated in boldface.

second year of preschool (age, 3–5 years), the OO group received an average of 8 more hours per week than the HFA group, which could be clinically meaningful and reflects medium effect sizes.

When examining the subset of the sample from Connecticut and Massachusetts, the groups were significantly different from the 2.5- to 3-year age period and the first year of preschool, with medium to large effect sizes, with the OO group receiving more intervention hours than the HFA group. While the groups were not significantly different on the 2- to 2.5-year age period or the second year of preschool, effect sizes were medium to large with the OO groups having higher mean number of hours than the HFA group.

Although the percent of children receiving ABA differed, there were no significant differences in the weekly number of hours of ABA for those who received it, at any age period, when examining either the total sample or the Massachusetts/Connecticut subset of the sample. Not enough children in the HFA group received ABA therapy before 3 years of age to compare hours between the groups. Between 2 and 2.5 years, 8 OO children (32%) received an average of 22.1 hours (SD = 13.5), while between 2.5 and 3 years, 13 OO children (52%) received an average of 21.8 hours (SD = 14.5). For the 3 to 4 age period, 7 HFA children (21%) received an average of 28.2 hours (SD = 14.1), while 14 OO children (56%) received an average of 21.5 hours (SD = 11.3; $t = 1.2$; $p = .25$). At the 4 to 5 age period, 6 HFA children (18%) received an average of 31.2 hours (SD = 8.8), while 14 OO children (56%) received an average of 24.0 hours (SD = 10.5; $t = 1.5$; $p = .16$). Results for the Connecticut/Massachusetts

subgroup were quite similar to those for the entire sample, with no significant group differences. Thus, for both HFA and OO groups, when children did receive ABA intervention, the average number of hours per week was generally between 20 and 30.

Total intervention hours and ABA hours, for the entire sample and the Massachusetts/Connecticut subgroup, were reanalyzed using analyses of covariance, with age as a covariate, for 2 reasons. First, the literature has shown systematic bias of parent report after different periods,²⁹ which was relevant given the wide age range of participants in the current study. Second, because children in the study were receiving early intervention across more than a decade, intervention practices might have changed. In general, the pattern of results remained the same, with age accounting for minimal variance. However, one exception was found: for mean ABA hours for the Connecticut/Massachusetts sample for the 3- to 4-year age period, age accounted for 42% of the variance in the group means. As no other time period for the Connecticut/Massachusetts sample and no age periods for the entire sample showed any other effects for current age, it is assumed that this is a chance result. To confirm this interpretation, age was run against hours of intervention and hours of ABA as bivariate correlations for each age period, and none were statistically significant.

Pharmacologic and Complementary-Alternative Medicine Treatments

Four HFA participants were missing medication and complementary-alternative medicine treatment information, which is reflected in the numbers in Table 3.

Table 2. Types of Therapy by Age

| | HFA (Total = 28), % | OO (Total = 25), % | <i>p</i> (χ^2) | Effect Size Cramer's <i>V</i> |
|-----------------------------------|---------------------|--------------------|-----------------------|-------------------------------|
| 1.5–2 yr | | | | |
| ABA | 4 | 16 | .12 | .21 |
| Speech | 29 | 28 | .96 | .006 |
| Occupational therapy | 14 | 12 | .81 | .034 |
| Physical therapy | 4 | 8 | .49 | .096 |
| Developmental therapy | 0 | 16 | .028 | .30 |
| Sensory integration therapy | 4 | 8 | .49 | .096 |
| 2–2.5 yr | | | | |
| ABA | 4 | 40 | .001 | .45 |
| Speech | 32 | 52 | .14 | .20 |
| Occupational therapy | 18 | 32 | .23 | .16 |
| Physical therapy | 7 | 8 | .91 | .016 |
| Developmental therapy | 0 | 20 | .013 | .34 |
| Special school | 0 | 8 | .13 | .21 |
| Sensory integration therapy | 4 | 12 | .25 | .16 |
| 2.5–3 yr | | | | |
| ABA | 7 | 56 | <.001 | .53 |
| Speech | 50 | 64 | .31 | .14 |
| Occupational therapy | 29 | 48 | .15 | .20 |
| Physical therapy | 14 | 8 | .47 | .099 |
| Developmental therapy | 4 | 12 | .25 | .16 |
| Special school | 4 | 12 | .25 | .16 |
| Sensory integration therapy | 7 | 12 | .55 | .083 |
| First year of preschool (3–4 yr) | | | | |
| ABA | 32 | 60 | .042 | .28 |
| Speech | 71 | 56 | .24 | .16 |
| Occupational therapy | 46 | 60 | .32 | .14 |
| Physical therapy | 21 | 24 | .82 | .031 |
| Developmental therapy | 4 | 4 | .94 | .011 |
| Special school | 18 | 40 | .07 | .25 |
| Sensory integration therapy | 7 | 4 | .62 | .068 |
| Second year of preschool (4–5 yr) | | | | |
| ABA | 25 | 72 | .001 | .47 |
| Speech | 50 | 68 | .18 | .18 |
| Occupational therapy | 36 | 72 | .008 | .36 |
| Physical therapy | 21 | 24 | .82 | .031 |
| Developmental therapy | 4 | 20 | .06 | .26 |
| Special school | 14 | 36 | .07 | .25 |
| Sensory integration therapy | 0 | 4 | .29 | .15 |

HFA, high-functioning autism; OO, optimal outcome; ABA, applied behavior analysis. Significant values are indicated in boldface.

Overall, the HFA group was more likely to be prescribed pharmacological treatments. Currently, 47% of the HFA group is on at least 1 medication, compared with only 20% of the OO group, a significant difference (see Table 3). A majority of the HFA participants were prescribed a pharmacological treatment at some point in their lives (64%), versus only 24% of the OO participants.

The difference in medication frequency seems to be driven by the fact that the HFA participants were significantly more likely to be prescribed antipsychotics and antidepressants.

The OO and HFA groups did not differ in the use of a casein-free, gluten-free diet or in the use of dietary supplements (see Table 3).

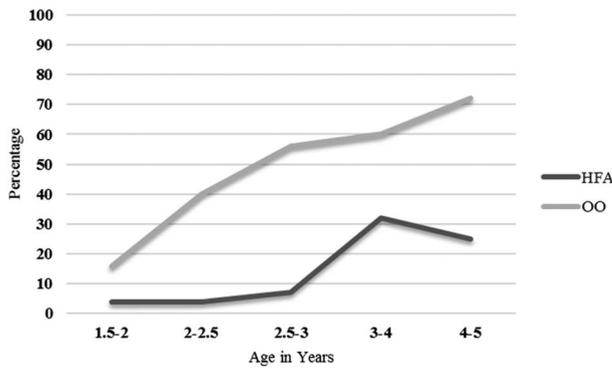


Figure 1. Percent of participants receiving ABA therapy, by age.

DISCUSSION

Summary of results is as follows:

1. **Early symptoms/age of concern:** Overall, severity was somewhat milder in the optimal outcome (OO) group; additional data in the study by Fein et al²⁰ suggest that these differences may have been in the social domain. Clinician judgment about the onset of developmental difficulties was not different between the groups, but parents of children in the high-functioning autism (HFA) group became concerned about the development an average of 5 months later, although still before the second birthday. The difference was much larger in referrals to specialists, with the OO group on average reportedly referred to a specialist at 26 months and the HFA group at 44 months, a difference of 18 months.

2. **Total intervention:** Consistent with earlier age of parent concern and earlier referral to a specialist, the percent of OO children receiving any intervention was significantly higher than those in the HFA group in the birth-to-3 age period (83 vs 48%) and also in the preschool period (92 vs 56%). For more specific age spans, the differences were significant or close to significance for the 2- to 2.5-, 2.5- to 3-, and 4- to 5-year age periods.
3. **Intensity of intervention:** The number of hours of intervention per week differed between the OO and HFA groups, for those children receiving intervention at 2 to 2.5 years (average of 14.8 vs 4.1 hours) and 2.5 to 3 years (21 vs 7.3 hours), with most of these hours coming from applied behavior analysis (ABA) therapy.
4. **Specific therapies:** More OO children than HFA children received ABA at 2 to 2.5, 2.5 to 3, 3 to 4, and 4 to 5, with very striking differences (e.g., 40 vs 4% at 2-2.5, 56 vs 7% at 2.5-3). In addition, more OO children received developmental therapy at 1.5 to 2 years of age (16 vs 0%) and at 2 to 2.5 years of age (20 vs 0%) and more OO children received occupational therapy at 4 to 5 years of age (72 vs 36%).
5. **Intensity of ABA:** For those children receiving ABA, the number of hours per week was similar between the groups, with 20 to 30 hours per week being the norm.
6. **Other treatments:** Children in the HFA group were more likely to have received medication, especially antipsychotics and antidepressants. There were no group differences in the percent of children receiving special diets or supplements.

Table 3. Pharmacologic and Complementary-Alternative Medicine Treatments

| | OO (n = 25), % | HFA (n = 32), % | <i>p</i> (χ^2) | Effect Size Cramer's <i>V</i> |
|---|----------------|-----------------|-----------------------|-------------------------------|
| Any medication—current | 20 | 50 | .020 | .31 |
| Any medication—ever | 24 | 69 | .001 | .44 |
| CNS stimulant—current | 16 | 19 | .79 | .036 |
| CNS stimulant—ever | 24 | 38 | .28 | .14 |
| Antidepressant—current | 4 | 25 | .031 | .29 |
| Antidepressant—ever | 4 | 50 | <.001 | .50 |
| Atypical Antipsychotic—current | 0 | 13 | .067 | .24 |
| Atypical Antipsychotic—ever | 0 | 25 | .007 | .36 |
| Anticonvulsant—current | 0 | 6 | .20 | .17 |
| Anticonvulsant—ever | 0 | 6 | .20 | .17 |
| Norepinephrine reuptake inhibitor—current | 0 | 9 | .12 | .21 |
| Norepinephrine reuptake inhibitor—ever | 0 | 13 | .067 | .24 |
| Alpha-2 adrenergic agonist—current | 4 | 9 | .43 | .10 |
| Alpha-2 adrenergic agonist—ever | 4 | 9 | .43 | .10 |
| Benzodiazepine—current | 0 | 6 | .20 | .17 |
| Benzodiazepine—ever | 0 | 6 | .20 | .17 |
| Casein-free, gluten-free diet | 23 | 30 | .56 | .081 |
| Dietary supplements | 40 | 41 | .96 | .006 |

HFA, high-functioning autism; OO, optimal outcome; CNS, central nervous system. Significant values are indicated in boldface.

Consistent with our hypothesis, the results of the present study suggest that children who go on to later achieve an optimal outcome are more likely to get intervention very early in life. The majority of the OO group (83%) got intervention before 3 years of age, and most of the rest received intervention by preschool age, while only about half of the HFA children obtained intervention before kindergarten. Among those who did get intervention, the OO children received more hours. The biggest difference was in ABA, with very striking differences between the groups, with large effect sizes between 2 and 3 years and between 4 and 5 years. The results suggest that most children in the HFA group are not getting ABA early in childhood; although the rates increase when they start school, they still never match the level of the OO group.

Contrary to our hypothesis, of children who did receive ABA, the children in the OO group did *not* receive more hours. This suggests that once ABA programs are implemented, the hours per week are relatively invariant. These findings are consistent with the study by Luiselli et al¹⁴ suggesting that the length of ABA intervention in months per year and an early start may be crucial.

Results also indicate that neither particular types of intervention nor the number of hours of early intervention is sufficient to predict outcome. Some children in the OO group had very limited early intervention, while some children in the HFA group received intensive early intervention. As treatment characteristics alone cannot predict outcome, other factors, such as child characteristics, need to be considered when studying prognosis. Results reported by Fein et al²⁰ indicated that despite the severity of symptoms in all domains within the autistic range, the OO group seemed to show somewhat milder symptoms in the social domain, but not in communication or repetitive behavior, in early childhood.

The results of the present study indicate that children who retain their autism diagnosis are more likely to receive pharmacologic treatments, particularly antipsychotic and antidepressant medications. Although we do not have information about specifically when or why these medications were prescribed, it is likely that children in the HFA group had more mood and behavioral disturbances than those in the OO group. It is highly unlikely that taking these medications themselves reduced the chances of the children achieving optimal outcomes. Rather, it may be that increased mood and behavioral difficulties interfere with intervention or occur in children with different presentations of autism that are more resistant to improvement. This is consistent with the findings in the literature that these mood and behavioral disorders are frequently comorbid with autism.³⁰ In addition, one quarter to one third of children and adolescents in both the groups were given a central nervous system stimulant at some point in their lives, suggesting that attentional difficulties are clearly present and persistent in

many children and adolescents with both the HFA and OO groups.³¹

There were no differences between the groups in the use of special diets or dietary supplements. Therefore, consistent with the previous literature,^{16,19} complementary-alternative medicine treatments do not seem to be effective in producing optimal outcomes from autism, although individual responders cannot be ruled out by our data.

Limitations and Future Directions

The most significant limitation of the present study is that the intervention data are based entirely on retrospective parent report. Particularly, given the large age range of participants, parents were being asked to remember specific details about intervention years prior to the study. It is possible that parents recalled specific intervention details incorrectly. However, given that the groups were matched on age, recall bias due to age should be equally present across the groups. It is possible that the children's different outcomes, although both groups were high functioning, influenced parent recall in a systematic way. In addition, we were unable to use objective measures to directly compare the 2 groups on symptom severity at the time of initial diagnosis. The participants were evaluated by many different clinicians and given multiple different tests across a wide range of ages; therefore, it is not possible to compare early histories on any particular standardized measure. As these data are unavailable, there is a chance that the 2 groups differed in symptom presentation in some meaningful way. Longitudinal studies that prospectively follow children from early childhood through latency age and adolescence would be definitive in measuring the impacts of early intervention.

An issue with the design of the study was that the children in the OO group had to be diagnosed with autism before 5 years of age, which was not required in the HFA group. Therefore, it is possible that the children in the HFA group were diagnosed later on average, leading to less early intervention. However, clinical judgment suggests that the developmental difficulties arose at the same time in both the groups. In addition, based on parent report, overall autism symptom severity was somewhat greater in the HFA than in the OO group, although both groups had clear early histories of ASD, and many children in the OO group had severe early clinical pictures.²² Future studies should carefully match groups on the age of diagnosis to eliminate this confound to intervention history. However, one would expect that a more severe early picture (in the HFA group) would lead to *earlier* diagnosis, referral to specialists, and intervention, which suggests that group differences in the age of symptom onset does not account for the later age of referral and intervention in the HFA group.

A confound in the results is that ABA treatments tend to be administered for many more hours than the other treatments reported by parents. Therefore, because more of the OO group received ABA, they would be

likely to receive more hours of treatment. In our data, it is not possible to disentangle whether the total intensity of treatment or ABA itself contributed more to the outcome.

Another major limitation is that the quality of the interventions received by the children in the study could not be assessed. Even if parents accurately reported the hours and ages of intervention, it was not possible to evaluate the fidelity of the intervention or the provider's expertise. To attempt to address this, we examined the subset of the sample from Connecticut and Massachusetts because early intervention training and providers are more similar within and between these states than they may be elsewhere in the United States and in Canada. The findings with this subset were largely the same. Unfortunately, there is still considerable variability in the quality of interventions between individual providers within any state, which could greatly impact a child's outcome. Therefore, randomized control trials looking at the efficacy and effectiveness of different types of early interventions, with the assessment of quality, and different intensities of specific interventions are necessary. As discussed by Reichow et al,³² only 1 strong randomized control trial exists for early intervention in autism, indicating this is an important target for future research.

The sample was relatively homogenous, in geography, participants, ethnicity, and socioeconomic status. This was both a strength and weakness. Greater demographic similarity reduces the possibility of confounds due to these factors. That said, the results of the present study may not be generalizable to a more diverse sample. In addition, the makeup of the current sample argues against the results being accounted for by recruitment bias. ABA therapy is relatively accessible in Connecticut and Massachusetts compared to many other states (e.g., in Connecticut, there are currently 8 autism-specific early intervention programs that cover the state, the majority of which offer intensive ABA therapy to children younger than 3 years) (<http://www.birth23.org/programs/autism/>). In our sample, 70% of children in the HFA group came from Connecticut and Massachusetts, compared with only 48% of children in the OO group, arguing against a recruitment bias in favor of OO children coming disproportionately from these states where ABA is relatively more available.

A further limitation is that a medical workup was not part of the study. Although children with fragile X syndrome were excluded based on parent report, no genetic testing was conducted as part of the study; therefore, it is possible that participants had this mutation without parental knowledge. In addition, other genetic contributors to autism could not be identified. Future research that examined different possible genetic causes or other etiologies of autism would be very important.

Some limitations were also present in the method and design of the questionnaires filled out by parents in the present study. As the information was obtained by questionnaire, there was a greater possibility of missing and

incorrect data. In addition, the questionnaire did not ask about exact start and end dates of the different treatment types, so total intervention hours from birth to kindergarten could not be computed and compared across the groups. Finally, for the pharmacologic and complementary-alternative medicine treatments, the parents were only asked about current and past treatments. Therefore, it was not possible to determine what children were given during the earliest years. Future studies may be best served by obtaining intervention data through structured interviews, rather than through questionnaires.

Although retrospective parent report has inherent weaknesses, the uniqueness of the current sample of OO children, matched on key characteristics to an HFA group, and the striking differences in reported provision of early intervention, and ABA in particular, are worth considering as the basis for future, longitudinal studies. If confirmed, these results reinforce the importance of early, ongoing developmental surveillance and autism screening at appropriate ages, with prompt referral for diagnostic evaluation and intervention, to maximize the possibility of an optimal outcome.

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