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The effects of intellectual functioning and autism severity on outcome of early behavioral intervention for children with autism

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Abstract

This study assessed the relation between pre-intervention variables (cognition, socialization and communication) to outcome in young children with autism.

Method: Twenty five children with autism (20–32 months) were enrolled in intensive behavior intervention. The children were divided into groups based on their IQ scores and on the severity of their social interaction and communication deficits [per autism diagnostic observation schedule (ADOS) scores]. Six developmental-behavioral domains including, imitation, receptive language, expressive language, nonverbal communication skills, play skills and stereotyped behaviors were assessed at pre- and post-1 year of intervention times.

Results: Significant progress was noted in all the six developmental-behavioral domains after 1 year of intervention. Children with higher initial cognitive levels and children with fewer measured early social interaction deficits showed better acquisition of skills in three developmental areas, receptive language, expressive language and play skills. Both groups showed better progress in Receptive language skills. Better progress in expressive language was associated with the child's social abilities, while more significant progress in play skills was related to pre-intervention cognitive level.

Conclusions: These findings emphasize the importance of early intensive intervention in autism and the value of pre-intervention cognitive and social interaction levels for predicting outcome.

Keywords: Autism; Behavioral intervention; Predicting variables

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Autism spectrum disorder (ASD) is a neurodevelopmental disorder that results in significant lifelong disability (Tager-Flusberg & Joseph, 2003; Wolery & Garfinkle, 2002). ASD has diverse clinical manifestations, behavioral phenotypes, and developmental dimensions, and these complicate research and clinical practice in regard to diagnosis, etiology, and selecting appropriate intervention. A striking feature of autism is its variability – some children speak in complete sentences while others will never learn to speak; some children remain aloof while others are affectionate and interested in interacting with others. This great variability is also found in children's response to intervention – some will show limited progress in therapy and others make rapid and remarkable gains.

Many studies describe the effectiveness of various interventions aimed at reducing the general level of impairment in autism. Most such studies have concentrated on behavioral approaches, known as applied behavior analysis (ABA) (Morris, Maurice, Greene, & Luce, 1996). These approaches were used in home-based programs (Anderson, Avery, DiPietro, Edwards, & Christian, 1987; Birnbrauer & Leach, 1993; Eikeseth, Smith, Jahr, & Eldevik, 2002; Howard, Sparkman, Cohen, Green, & Stanislav, 2005; Lovaas, 1987; McEachin, Smith, & Lovaas, 1993; Sheinkopf & Siegel, 1998) and in center-based programs (Dawson, Ashman, & Carver, 2000; Fenske, Zalenski, Krantz, & McClannahan, 1985; Harris, Handleman, Gordon, Kristoff, & Fuentes, 1991).

Most of the outcome studies using behavioral techniques noted that nearly half of the participants made substantial gains on standardized tests, functioned successfully in mainstream classrooms and were indistinguishable from typically developing children at the same ages. The rest of the children made only mild to moderate progress on standardized tests and continued to display typical deficits of autism (Lovaas, 1987; McEachin et al., 1993; Sheinkopf & Siegel, 1998). An important question to ask is what accounts for the dramatic change with therapy in the responding group? Is it the type of intervention, the intensity of treatment, the age at diagnosis, or a particular child's characteristics?

Variables such as age, cognitive abilities, language and social skills at the time of diagnosis may affect outcome of intervention. Previous studies that looked for predictors of outcome differed in the selection of subjects, the evaluation procedure, autism severity, and the outcome measures used. The mean age range of treated children at the beginning of intervention was between 32 and 57 months in most studies (review in Rogers, 1998; and in Eaves & Ho, 2004). Studies that examined the effect of age found that the younger groups achieved better outcome (Harris & Handleman, 2000). It is possible that intervention started at a very young age will yield a better outcome because plasticity of certain neural systems at this early age permits significant changes in the CNS with treatment (Dawson et al., 2000).

Several studies looked for possible predictors of outcome including the severity of social disability (Beglinger & Smith, 2001; Wing & Gould, 1979), neuro-cognitive abilities, mostly using IQ as a major measure (Borden & Ollendick, 1994; Waterhouse et al., 1996), and language profile (Tager-Flusberg & Joseph, 2003). The two variables consistently identified as early predictors of outcome are IQ and language (Gillberg & Steffenburg, 1987; Tager-Flusberg & Joseph, 2003). Several studies have contended that the cognitive level and adaptive behavior may be accurate measures for prognosis (Volkmar, Cohen, Bergman, Hooks, & Stevenson, 1989; Waterhouse et al., 1996). Higher IQ measures, especially at older ages, were predictive of better progress (Szatmari, Bryson, Boyle, Streiner, & Duku, 2003; Volkmar, 2002). Many studies found that acquiring language before the age of 5 years is also a good predictor of better outcome (Howlin & Goode, 1997; Venter, Lord, & Schopler, 1992). Eaves and Ho (2004) reported that young, higher functioning children with milder autism (based on the childhood autism rating

scale-CARS) were the most improved. The children in their study received different types of intervention and no relationship was found between type and amount of intervention and changes in IQ and CARS scores over time. It is difficult to draw definite conclusions from previous studies regarding predictive measures, as the studies used different autism assessment tools, compared different age groups, used different outcome measures, and implemented different interventions (Beglinger & Smith, 2001; Volkmar, Klin, & Cohen, 1997). In addition, there is a paucity of studies that have specifically looked for a profile of responsiveness to interventions in autism (Rogers, 1998).

The current study addressed the following questions: first, are pre-intervention cognitive, social interaction and communication characteristics related to post-intervention developmental outcome in young children with autism? Second, are gains significant in all the measured post-intervention developmental domains or are they restricted to specific areas?

To obtain reliable answers to these questions, this study controlled for age, method of diagnosis, and type and intensity of intervention (center-based ABA program). This study is innovative as all the participants were very young children under the age of 32 months, all diagnosed with autism by using standardized assessment tools to obtain reliable and valid classification of autism.

1. Method

1.1. Participants

The research group included 29 children (25 boys and four girls) diagnosed with autism. Of these, four children (two boys and two girls) were excluded from the study because of co-morbidities including genetic syndromes and seizure disorder. Thus, 25 (23 boys and two girls) diagnosed with autism, aged 20–32 months (mean age 26.6 months), participated. All children were diagnosed using the autism diagnostic interview-revised (ADI-R) protocols (Lord, Rutter, & LeCouteur, 1994) and the autism diagnostic observation scale (ADOS) protocols (Lord, Rutter, DiLavore, & Risi, 1999) and met established DSM-IV criteria for autism (American Psychiatric Association, 1994). The protocols were administered by an independent clinician. For all subjects, the scores on the ADI or the ADOS tests were above the cut-off points for autism in all domains examined (23 children obtained scores for autism on both tests, two children reached the cut-off points for autism on ADI-R test and for autism spectrum on the ADOS). In examining vocabulary, 24 children had an expressive vocabulary of less than 10 words and one child used two-word utterances. No cognitive criterion was used for selection of the participants.

The children's parents signed an informed consent form approving the use of the data obtained during the diagnosis and the intervention processes for research according to IRB requirements. Children diagnosed with autism received intervention whether their parents signed the consent form or not. Parents received no monetary compensation for signing the informed consent form.

1.2. Design

The children were referred for diagnosis by pediatricians, developmental pediatricians, psychologists, or the parents themselves.

The initial evaluation included autism diagnosis, and cognitive and adaptive ability tests. All participants had a neurological examination and medical tests to exclude genetic disorders and co-morbidities.

Six developmental-behavioral domains, imitation, receptive language, expressive language, play skills, nonverbal communication skills, and stereotyped behaviors were evaluated using specific detailed scales (described below). Scoring of these scales was based on the daily data obtained from the child's chart, collected and graphed by the child's therapists during the intervention. The intervention plan addressed these developmental-behavioral domains in the child's curriculum.

Pre-intervention (PRI) scoring of the developmental-behavioral skills (baseline) was performed within the first month of enrolment in the intervention program. The same post-intervention (POI) scoring was obtained from the charts a year after the intervention starting date.

The effects of intellectual functioning and autism severity on early intervention results were assessed. Participants were divided according to their pre-intervention IQ scores to evaluate the effect of the child's cognitive level on his or her post-intervention progress in the six developmental-behavioral domains. The range of IQ scores was 50–103 points (median = 70.0), with 12 children with IQ scores of 50–70 points, and 12 with scores of 71–103 points (4/12 between 71 and 79, 7/12 between 80 and 88 points and 1 had 103 points). Those who achieved less than 70 points (median score) were defined as low IQ scorers (LIQ) and those with 71 points or above were defined as high IQ scorers (HIQ).

To evaluate the effect of pre-intervention autism severity on the child's progress with the intervention, participants were divided according to the median scores in the two sections of ADOS-module I (language and communication and reciprocal-social interaction). In the language and communication section the range was 6–22 (median = 13.0), with the 12 children who achieve below 13 points being referred to as high communication (HC) group and the 12 children who achieved above 13 points were referred as low communication (LC) group. HC means fewer deficits typical for autism for this group in the area of communication as defined in the ADOS protocol. In the reciprocal social interaction section the range was 8–29 (median = 16.0), with the 12 children who achieved below 16 points being referred as high social (HS) group and the 12 who achieved above 16 points referred to as low social (LS) group. HS means fewer deficits typical for autism in the area of social interaction as defined in the ADOS protocol.

1.3. Instruments

1.3.1. Instruments used for the evaluation of autism severity

ADI-R—A semi structured interview (Lord et al., 1994) administered to parents was designed to make a diagnosis of autism according to both DSM-IV and ICD-10 criteria.

ADOS—the ADOS is a semi-structured, interactive schedule designed to assess social and communicative functioning in individuals who may have an autism spectrum disorder. The assessment involves a variety of social occasions and ''presses'' designed to elicit behaviors relevant to diagnosing autism. The schedule consists of four developmentally sequenced modules, of which only one is administered, depending on the examinee's expressive language. Each module includes a standardized diagnostic algorithm composed of a subset of the social and communicative behavior rated (Lord et al., 1999), with lower scores indicating better social and communicative functioning. In the current study, because all the children were young and preverbal (or used single words only) they were all evaluated using module 1.

1.3.2. Instruments used for the evaluation of cognitive ability

The Bayley Scales of Infant Development, Second Edition (*BSID-II*) (Bayley, 1993). This test was used for preverbal children. It is a widely used measure of infant development that has well-

developed norms and good reliability and validity. It is administered to children age 1–42 months. The mental developmental index (MDI) is derived from this scale ($M = 100$, S.D. = ± 15).

Stanford-Binet Intelligence Scale Fourth Edition (Thorndike, Hagen, & Sattler, 1986). This test was used for verbal children. The test measures overall cognitive development as well as four different cognitive domains—verbal, reasoning, quantitative reasoning, abstract/visual reasoning and short-term memory skills ($M = 100$; S.D. = 15).

1.3.3. Developmental-behavioral scales

The scales were based on a developmental list of skills and valid norms (Alpern, Boll, & Shearer, 2000; Bates & Tomasello, 2001; Owens, 1992; Partington & Sundberg, 1998) and typical child developmental milestones (Appendix A). Validity content of these scales was approved by two child development specialists. Both specialists examined the developmental stages and hierarchy of each skill on the scale and their comments were incorporated into the Scales before their administration.

Scoring of the scales was based on the child's daily recorded progress charts at pre- and post-intervention times. Each item within the scales was accurately defined—for example, ''autosymbolic play'' was defined when the child pretended at self-related activities (McCune, 1995). The raters were blind to the child's initial ADOS and IQ scores and received clear guidelines regarding each definition.

The overall Imitation score reflected the sum of the ratings assigned for motor imitation, imitation with objects, and verbal imitation; overall receptive language score was based on the sum of the ratings for understanding of objects' names, instructions, and emotional words (such as ''happy,'' ''angry''); expressive language score was a sum of the ratings for expressive vocabulary, syntactic abilities and pragmatic skills; and the score of the restricted and stereotyped behavior consisted of ratings in stereotyped motor behaviors, restrictedness, repetitive play and difficulties with changes. The current study focuses on the change in scorings at pre- and post-intervention times. Initial ADOS and cognitive scores served as predictors for outcome. ADOS scorings included the summing of all items in each section: language and communication, and reciprocal social interaction. Scores in each item ranged between 0 and 3. The scorings of the developmental-behavioral assessments and post-intervention IQ scores served as the dependent variables in the study.

1.3.4. Intervention

All the children included in the study attended a center-based applied behavioral analysis (ABA) program. A trained behavior analyst planned and supervised the individual intervention curriculum of each child. The program was both intensive and comprehensive, and addressed various developmental and behavioral areas. Treatment was provided one-on-one by skilled behavioral therapists for at least 35 weekly hours. Parents learned how to use behavioral methods at home and worked with the program supervisor on developmental goals for use in natural environments.

2. Results

2.1. Pre- and post-intervention analyses

To examine differences between pre- and post-intervention scorings, a one-way MANOVA with repeated measures was performed at the pre- (PRI) and post-intervention (POI) times for the

Table 1
Behavioral assessment means, standard deviation, F and η^2 values at the pre- and post-intervention time

	M	S.D.	$F(1,24)$	η^2
Imitation				
PRI	2.36	2.61	162.1^{***}	.871
POI	8.00	1.44		
Receptive language				
PRI	1.64	1.87	154.2^{***}	.865
POI	6.28	2.34		
Expressive language				
PRI	.76	1.69	55.7^{***}	.699
POI	5.84	3.69		
Play skills				
PRI	.92	1.19	62.0^{***}	.721
POI	3.16	1.62		
Nonverbal skills				
PRI	.80	.76	72.0^{***}	.750
POI	2.00	.76		
Stereotyped behaviors				
PRI	6.48	3.23	24.2^{***}	.503
POI	3.36	2.62		

*** $p < .001$.

scorings of all the six developmental-behavioral domains (imitation, receptive language, expressive language, play, nonverbal communication skills and stereotyped behavior). The MANOVA revealed significant time effect ($F(6,19) = 40.2$, $p < .001$, $\eta^2 = .927$) meaning that significant change was observed in all the six developmental-behavioral domains (Table 1).

In addition, one-way ANOVA with repeated measures was performed for the IQ scores at the pre- and post-intervention times. The ANOVA revealed a significant time effect ($F(1,21) = 31.3$, $p < .001$, $\eta^2 = .610$) since the mean IQ scores increased from the PRI ($M = 70.67$, S.D. = 17.01) to POI time ($M = 87.90$, S.D. = 16.56) by an average of 17.3 points.

2.2. *Pre-intervention cognitive ability, and autism severity and outcome*

To evaluate the effect of pre-intervention cognitive ability, the high (HIQ) and low IQ (LIQ) groups were compared. Scorings in the developmental-behavioral domains differed between the two defined groups (HIQ and LIQ) at the pre-intervention time, and therefore a one-way MANCOVA was performed on all six domains.

The MANCOVA revealed significant effect (F (6,11) = 3.30, $p < .05$, $\eta^2 = .643$). The HIQ group showed greater progress than the LIQ group for the following developmental-behavioral domains: receptive language, expressive language, play skills, and nonverbal communication skills.

Differences between the HIQ and LIQ groups at the post-intervention time (controlling for IQ scores) were significant for the imitation and receptive language domains.

The same trend was observed for the play skills domain, where the HIQ group differed from the LIQ group in their scorings at post-intervention time although the difference was not statistically significant ($p = .07$) (Fig. 1a–c and Table 2).

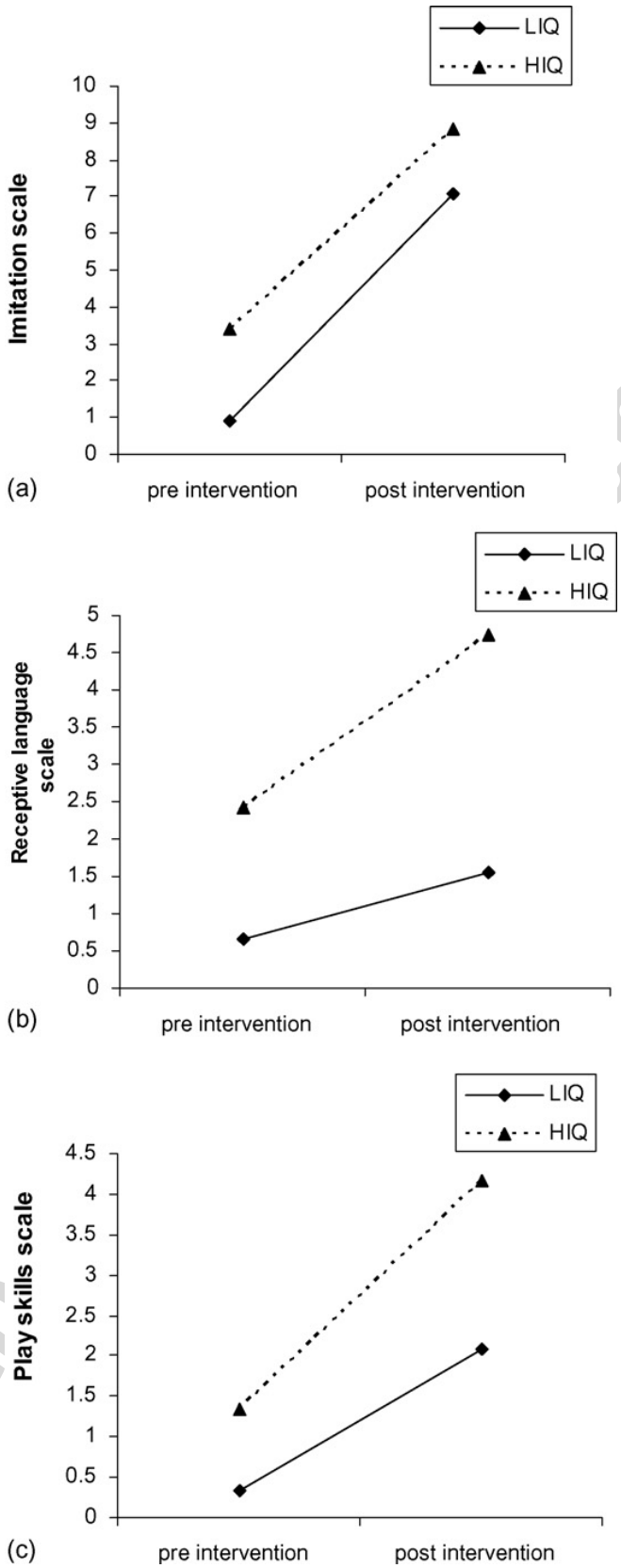

Fig. 1. (a) Imitation scores for low and high IQ groups at pre- and post-intervention time. (b) Receptive language scores for low and high IQ groups at pre- and post-intervention time. (c) Play skills scores for low and the high IQ groups at pre- and post-intervention time.

Table 2
Means and standard deviations F and η^2 values for the LIQ and HIQ groups at the pre- and post-intervention times

	Time				LIQ/HIQ Post intervention	
	Pre-intervention		Post-intervention		$F(1,16)$	η^2
	LIQ	HIQ	LIQ	HIQ		
Imitation						
M	.91	3.42	7.08	8.83	9.86**	
S.D.	1.73	2.54	1.62	.39		
Receptive language						
M	.67	2.42	4.75	7.58	5.12*	
S.D.	1.15	2.02	2.26	1.31		
Expressive language						
M	.83	1.25	3.67	7.67		
S.D.	.28	2.22	3.14	3.08		
Play						
M	.33	1.33	2.08	4.17	3.62^	
S.D.	.89	1.15	1.44	1.11		
Nonverbal com.						
M	.42	1.08	1.50	2.42		
S.D.	.51	.79	.52	.67		
Rep. behaviors						
M	7.58	5.92	4.33	2.67		
S.D.	2.97	2.91	2.50	2.50		

* $p < .05$.
** $p < .01$.
^ $p = .07$.

For both groups (HIQ and LIQ) the differences between pre- and post-intervention times were significant ($p < .001$) in all the developmental-behavioral domains (paired comparison tests). However, for the receptive language and play skills domains the effect was greater for the HIQ group (η^2 = .960, .816 respectively) than for the LIQ group (η^2 =.830, 668 respectively). For the Imitation domain the effect was greater for the LIQ group (η^2 = .920) than for the HIQ group (η^2 = .853).

To evaluate the effect of pre-intervention autism severity on outcome, ADOS test scorings in the social and communication domains at PRI were assessed. High (HS) and low social (LS) groups and high (HC) and low communication (LC) groups were compared.

The results showed higher scorings for the HS group than for the LS group at the pre- and post-intervention times (Table 3).

Because scorings in the developmental-behavioral domains differed between these four defined groups (HS and LS, HC and LC) at pre-intervention time, two one-way MANCOVA tests were performed on the scorings of all the developmental-behavioral domains. One MANCOVA test was performed for the LS and HS groups, and another one for the HC and LC groups.

The MANCOVA for the LS and HS groups did not reveal any significant effect. However the univariate ANCOVA for the receptive language domain yielded significant effect. The same trend was observed for the expressive language domain, although it did not reach significance. In the

Table 3
Means and standard deviations, F and η^2 values for the LS and HS groups at the pre- and post-intervention times

	Time				LS/HS Post-intervention	
	Pre-intervention		Post-intervention		$F(1,11)$	η^2
	LS	HS	LS	HS		
Imitation						
M	1.08	3.83	7.50	8.41		
S.D.	1.72	2.69	1.44	2.62	4.71*	.228
Receptive language						
M	1.00	2.41	4.91	7.58		
S.D.	1.28	2.15	2.19	1.78		
Expressive language						
M	.25	1.33	3.50	7.92	3.31^	.171
S.D.	.45	2.31	3.12	2.91		
Play						
M	.67	1.25	2.33	4.00		
S.D.	1.15	1.21	1.37	1.53		
Nonverbal com.						
M	.58	1.08	1.58	2.42		
S.D.	.51	.90	.51	.79		
Rep. behaviors						
M	7.58	5.42	4.75	2.08		
S.D.	2.27	3.87	2.26	2.42		

* $p < .05$.
^ $p = .09$.

receptive and expressive language domains the differences between pre- and post-intervention times were significant for both groups ($p < .001$). However the HS group showed greater improvement in scorings than the LS group in these two domains (Fig. 2a and b).

Comparison of the two groups (HS and LS) regarding their progress in IQ scores (dependent variables) with intervention revealed no differences. The HS group improved from PRI time ($M = 80.45$, S.D. = 15.15) to POI time ($M = 96.50$, S.D. = 10.45) similarly to the LS group (PRI–$M = 61.00$, S.D. = 12.10; POI–$M = 76.82$, S.D. = 17.32) after one year of intervention.

The MANCOVA for the HC and LC groups did not yield a significant effect (F (6,11) = .997, p = NS, $\eta^2 = .348$), not for the six univariate ANCOVAs for the six developmental-behavioral domains and not for the IQ scores.

2.3. Correlations between the developmental-behavioral domains scorings

To evaluate the relationships between the changes in the six developmental-behavioral domains, Pearson correlation tests were performed over the *scorings difference*. The scoring difference was calculated by subtracting the pre-intervention scores from the post-intervention scores. The results indicated significant correlations between the scoring difference of receptive language, expressive language, and play skills and between nonverbal communication skills, expressive language, and play skills. These results indicated that greater improvement in one domain correlated with the improvement noted in the other domain (Table 4).

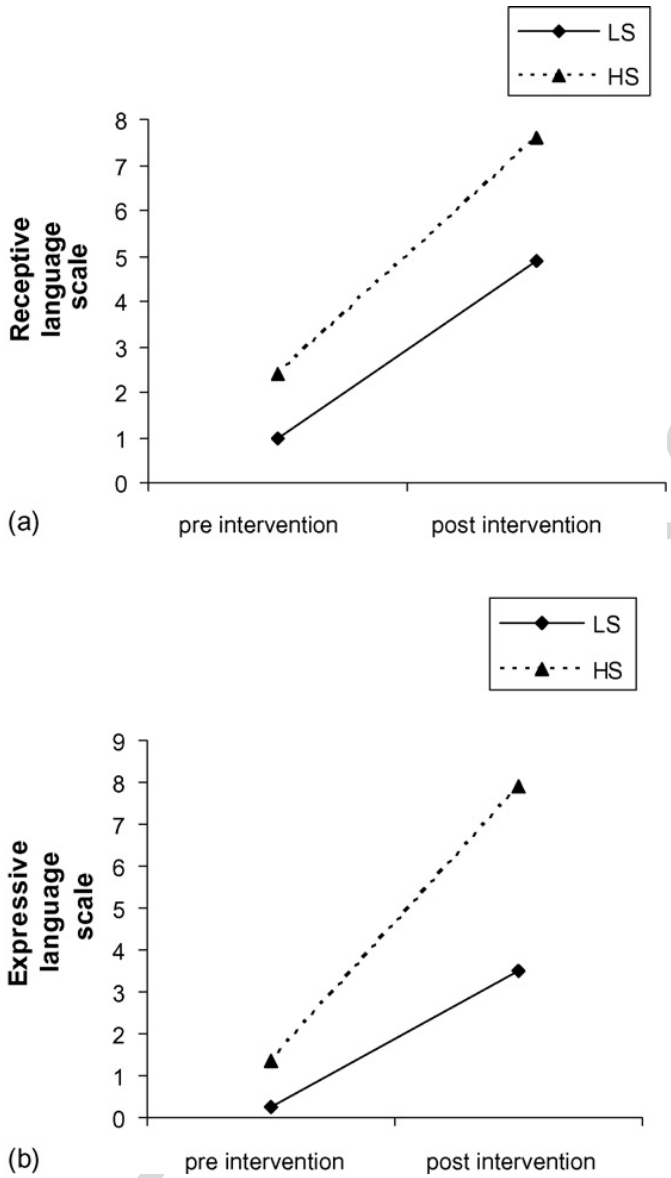

Fig. 2. (a) Receptive language scores for low and the high social groups at pre- and post-intervention time. (b) Expressive language scores for low and the high social groups at pre- and post-intervention time.

To determine the relationship between ADOS scores and IQ scores, Pearson correlations were performed. Significant negative correlation was found between the ADOS-reciprocal-social interaction and IQ ($r = -.606$; $p < .01$). This means that higher IQ scores correlated with fewer deficits in social interaction skills as measured according to the ADOS protocol. Correlation was high but not significant for ADOS-language and communication scores and IQ ($r = -.365$; $p = .09$).

Table 4
Correlations between the developmental-behavioral domains scoring difference

	Expressive language	Play skills
Receptive language	.549**	.724**
Play skills	.444*	
Nonverbal communication	.435*	.530**

* $p < .05$.
** $p < .01$.

3. Discussion

In this study we examined the association between variables assessed in young children with autism before starting an intervention program and after one year of intervention. In addition, we assessed the progress of very young children with autism in various developmental-behavioral domains and in their cognitive abilities before and after a year of intensive behavioral intervention.

This study focused on the impact of specific cognitive, social and communication characteristics of children with autism at diagnosis on their developmental outcome, while other variables such as age at start of therapy, type of intervention, and intensity of treatment are controlled. Our findings reveal that children with higher initial cognitive levels and children with fewer measured early social interaction deficits show better acquisition of developmental skills. This is especially noted in three developmental areas: receptive language, expressive language, and play skills. In this study, the progress in receptive language domain is highly related to pre-treatment cognitive abilities and social abilities. Children with higher pre-treatment cognitive levels or with better measured social reciprocal abilities advance more in their receptive language than do children with lower pre-treatment cognitive levels and social abilities. Progress in expressive language is associated to a greater degree with the child's social abilities, while progress in play skills is related to a greater degree to cognitive level. While the IQ and social deficits are found to be related to outcome, the severity of the measured communication deficits is not related to outcome in any specific developmental domain.

This study is consistent with previous reports suggesting that the cognitive ability in children with autism correlates with outcome of therapy (Stevens et al., 2000; Szatmari et al., 2003; Volkmar, 2002; Volkmar et al., 1989; Waterhouse et al., 1996). In addition to the importance of cognitive level in regard to outcome, this study finds that social-reciprocal interaction deficits quantified by standardized tests also correlates significantly with outcome. It is interesting to note that when using the final IQ scores as the dependent variable, the initial reciprocal social interaction measure could not predict the change in pre/post treatment IQ scores. Both groups – the one with poor social skills and the one with better social reciprocal abilities – shows the same significant improvement in IQ scores (around 16 points) after one year of intensive behavioral intervention. This is consistent with previous studies emphasizing the effectiveness of intensive therapy based on ABA principles reflected in significant cognitive gains (Harris & Handleman, 2000; Harris et al., 1991; Howard et al., 2005). However, the gain in IQ scores in this study is acquired regardless of pre-treatment autism severity in communication and in reciprocal social-interaction domains.

Most studies identify IQ scores in children with autism either at the time of diagnosis or later in the course of therapy as an important factor that affects outcome (Gillberg & Steffenburg, 1987; Stevens et al., 2000; Szatmari et al., 2003; Volkmar, 2002; Volkmar et al., 1989; Waterhouse et al., 1996). In the current study intervention type, period and intensity are all constant, therefore the predictive value of pre-treatment IQ for intervention outcome is further emphasized. Our study is in agreement with the original work done by Lovaas (1987), which reports pretreatment mental age is the only significant variable for the behaviorally treated autistic children with best outcome. The Lovaas study is similar to our study in regard to the children's age and intervention type; however the mean IQ of the children in our study is higher. A more general finding is described in Harris and Handleman (2000) who report the IQs of the children shortly after their admission to the intensive behavior intervention center relate to the children's later placement. Children with higher IQ (mean of 81) are found to be more likely to be

placed in regular education classes at follow-up than those with lower IQ (mean of 48). In conclusion, the current study emphasizes previous findings regarding the importance of cognitive level of children with autism to treatment outcome, while controlling for many variables (intervention type, length, intensity, age), including very young children (mean 27 months), and having broader IQ scores range.

Historically, the majority of previous publications on IQ distribution in autism, mostly from the 1970s, report that median IQ is 45–55 points. Standard estimates are that 70% of children with PDD have an IQ of 70 or lower. More recent epidemiological reports from 2000 and on, examining the entire PDD spectrum, describe mental retardation in 40–70% of the identified cases with autism (Baird et al., 2000: 40%; Bertrand et al., 2001: 63%; Fombonne, 2001: 45%; Kielinen, Linna & Moilanen, 2000: 50%). Our sample is similar to the recently described percentage of mental retardation in the autism population. In the current study, 50% of the participants have IQ below 70 points, which is in agreement with previous reports.

Studies addressing the significance of social interaction skills as predictors of outcome tend to use qualitative descriptions of the social disability, as they were established at an older age and not as a predictor for treatment outcome (Leigh, Beglinger, & Smith, 2001; Wing & Gould, 1979). One longitudinal study looks at two groups of children with autism characterized by particular patterns of social behavior. One group is described as ‘‘aloof and passive’’ and the other as ‘‘active but odd,’’ with higher IQ scores (Wing & Gould, 1979). The second group improves more than the first in functional, adaptive, and developmental skills (Fein et al., 1999). Children in the aloof group who are also cognitively delayed are the most difficult to treat (Wing, 1997). The current study is the first to use a quantitative measure of social interaction deficits taken from the ADOS test as a variable that can predict acquisition of specific developmental skills after implementing intensive therapy.

Studies looking at language skills as predictors of outcome identify early verbal and non-verbal communication as important predictors of outcome of adaptive behavior and communication skills, regardless of intervention type or intensity (Lord & Schopler, 1989; Tager-Flusberg & Joseph, 2003; Szatmari et al., 2003). The presence of language abilities, even abnormal abilities such as hyperlexia and echolalia may predict positive outcomes for the younger group of children with autism, but not for the older group (Fenske et al., 1985). Szatmari and colleagues (2003) describe that initial cognitive and language abilities predict progress in communication and social skills but not in repetitive and stereotyped behaviors. Most children in the current study were at their preverbal stage before the intervention was implemented. Therefore, language skills could not serve as a predictor for outcome.

The preverbal communication skills assessed by the language and communication measure of the ADOS test (corresponding to the first three DSM-IV criteria for autism in the communication domain) do not appear to be a good predictor of treatment outcome.

Although this study does not specifically focus on the effectiveness of ABA-based intervention (no control group), the findings show that children with autism make remarkable progress in cognitive levels and in several developmental domains (imitation, receptive language, expressive language, play skills, nonverbal communication skills and reduction of stereotyped behaviors) after a year of intervention. These results are in accordance with previous research on the effectiveness of intensive behavioral intervention (McEachin et al., 1993; Rogers, 1998). In addition, this study shows that children with a range of autistic symptom severity and cognitive impairments before the start of treatment significantly progress with intervention.

In this study the outcome for complex imitation skills is especially unique. These skills are considered core deficits of autism, yet the current study shows that they are acquired after

intervention even in children with severe autism or with low cognitive skills—at least in structured settings. For example, progress was especially noticeable for those with poor social interaction scores who, as previously mentioned, did not progress so well in their language and play skills. This finding emphasizes that certain skills can be taught in a structured teaching environment using behavioral principles. The observation that imitation improves with intervention and with age in young children with autism may suggest that early imitation deficits represent a specific delay, rather than a disordered or deviant developmental sequence (Stone, Ousley, & Littleford, 1997). Other studies note that rapid acquisition of imitation is a strong predictor of outcome (Stone & Yoder, 2001). Our findings merit further investigation of outcome for the group who acquired Imitation skills rapidly during intervention.

The developmental-behavioral domains outcome assessments showed high correlation between measures of linguistic abilities (receptive and expressive language), between measures of communication skills (expressive language and nonverbal communication skills) and between linguistic measures (receptive and expressive language) and play skills. These results are in accordance with previous reports that describe association between language and play development in typically developing children (Eisert & Lanorey, 1996; McCathren, Warren, & Yoder, 1996).

This study has several strengths that support the validity of the results. First, the group is homogenous in age at diagnosis, evaluation process, lack of co-morbidities, and use of the same intervention method (ABA). Second, the very young age of the group diagnosed with autism (Eaves & Ho, 2004) minimizes the effects of various confounders. Additionally, most intervention outcome studies had fewer than 20 participants in their cohort Lovaas (1987) had 19; Sheinkopf & Siegel (1998) had 11; and Fenske et al. (1985) had nine subjects, whereas the present study had 25 participants. Third, the raters of the developmental-behavioral domains in this study are blind to the predictor variables. Forth, diagnosis of autism is stringent using standardized tests that serve as the basis for group assignment (Matson, in press). Finally, the findings of the current study are not biased by selecting a specific sub-group (high functioning autism, PDD-NOS, etc.) in the autistic spectrum, as we included children with a range of autistic symptom severities. An additional by-product of this study is the developmental-behavioral domains scales. The significant results obtained in the study support their validity and enable researchers and clinicians to use them in the future.

The study limitation is the absence of a control group. In our study a control group of children not included in intervention is not available because of ethical reasons, since all the children diagnosed with autism are referred to early intervention.

There are several important clinical implications for these data. When diagnosing young children with autism, it is important to assess both the cognitive skills and social-reciprocal interaction deficits and abilities using standardized tests. Both measures are strongly related to outcome and are correlated between each other. These measures can help clinicians with assessment of responsiveness to intervention and with planning the treatment. In addition, early social-interaction abilities may be a pivotal skill that should be addressed in intervention programs.

The study also emphasizes the effectiveness of intensive intervention in very early age across autism severity range.

The outcome data encourage clinicians to teach imitation skills rigorously in the first stages of intervention, because these skills present an important stage in the process of learning and can be used to teach many developmental and self-help skills.

In the future it will be important to assess the effectiveness of different intervention approaches in regard to progress in social, communication, behavior, cognitive, and adaptive measures.

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Appendix A. Behavioral assessment scales

Imitation	
Object	Number of objects
	0, none
	1, 1–4
	2, 5–9
	3, More than 10
Motor	0, none
	1, simple movements
	2, complex movements
	3, series of movements
Verbal	0, none
	1, syllables
	2, words
	3, phrases
Receptive language	
Names	0, no
	1, 1–9 names
	2, 10–49 names
	3, more than 50 names
Instructions	Number of instructions
	0, none
	1, 1–9
	2, more than 10
	3, more than 10 + complex instructions
Emotions	0, none
	1, identifying in pictures
	2, identifying in self and other
	3, cause and effect
Language production	
Vocabulary	Number of words
	0, none
	1, 1–9
	2, 9–49
	3, more than 50
	4, more than 50 + abstract concepts
Syntax	Sentence type
	0, one word only
	1, two word phrases
	2, three word (or more) simple phrases
	3, other types of sentences (questions, complex)
Pragmatics	0, no spontaneous initiation
	1, verbal request

Appendix A (*Continued*)

		2, answers 3, statement 4, conversation	
Nonverbal communication	I. Eye contact 0, none 1, partial 2, full		II. Response to name 0, none 1, partial 2, full
	III. Responsive joint attention 0, no 1, yes		IV. Initiative joint attention 0, no 1, yes
Play	0, none 1, not functional 2, functional 3, autosymbolic play 4, symbolic play 5, pretend play 6, imaginative play 7, role play		
Stereotyped behaviors			
Motor stereotyped behavior			0, none 1, seldom 2, frequently 3, intensive
Restricted interests			0, does not exist 1, exist
Repetitive play			0, none 1, seldom 2, frequently 3, intensive
Response to changes			0, does not exist 1, exists

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