Effectiveness of a Novel Community-Based Early Intervention Model for Children With Autistic Spectrum Disorder

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Abstract

The Nova Scotia early intensive behavior intervention model–NS EIBI (Bryson et al., 2007) for children with autistic spectrum disorders was designed to be feasible and sustainable in community settings. It combines parent training and naturalistic one-to-one behavior intervention employing Pivotal Response Treatment–PRT (R. Koegel & Koegel, 2006). We followed 45 children (33 males, mean baseline age = 50 months) for 12 months. Mean gains of 14.9 and 19.5 months were observed on expressive and receptive language measures, respectively, for children with an IQ of 50 or more at baseline versus 6.1 and 8.4 months for children with IQs less than 50. Behavior problems decreased significantly over the 1-year treatment for both groups, but autism symptoms decreased only for those with an IQ of 50 or more.

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Effective early intervention for children with autistic spectrum disorders (hereafter referred to as autism) is widely recognized as a health priority (Charman & Howlin, 2003; Lord et al., 2005). Increased rates of diagnosis, with current estimated prevalence of at least 1 in 150 children (Fombonne, 2009), render autism the most common severe developmental disorder. The substantial child disability and family distress entailed by the high prevalence of autism constitutes a major challenge for health, education, and social services (Järbrink, Fombonne, & Knapp, 2003; Kogan et al., 2008). Thus, there is concern not only with the effectiveness, but also the escalating costs of early autism intervention programs and their feasibility in public systems of care.

Following the landmark study of Lovaas (1987, 1993), a considerable body of research has indicated that outcomes for children with autism are significantly enhanced by early intensive treatment based on applied behavior analysis (ABA). Lovaas' model of early intensive behavior intervention entails the use of ABA methods to target a comprehensive range of skills during children's early years. In the initial stages, the model relies primarily on a specific procedure, discrete trial training, carried out for up to 40 hr per week (Lovaas & Smith, 2003). The essential findings regarding the efficacy of the Lovaas model have been replicated in randomized controlled trials (e.g., Smith, Groen, & Wynn, 2000; Sallows & Graupner, 2005).

Systematic reviews have been conducted recently by Reichow and Wolery (2009), who restricted their review to the Lovaas model treatment, and Rogers and Vismara (2008), who considered all comprehensive early interventions for autism. Reichow and Wolery employed the criteria of Reichow, Volkmar, and Cicchetti (2008) and evaluated both group and single-subject studies for critical indicators of design quality (e.g., specification of participant characteristics, dependent and independent variables) as well as secondary indicators (e.g., measures of interrater reliability, treatment fidelity). These indicators are used to classify the strength of studies according to operational criteria. Rogers and Vismara used Nathan and Gorman's (2002) criteria, which accord Type 1 status only to randomized controlled trials that meet a variety of conditions (e.g., clear inclusion criteria, sufficient power, blind assessments). Studies that are Types 2 through 6 represent decreasing quality of evidence. Rogers and Vismara also classified treatments as well-established, probably efficacious, or possibly efficacious (Chambless et al., 1996, 1998); treatment manuals and specification of participant characteristics are among the requirements for the classification of a well-established treatment. Only the Lovaas model intervention was classified as well-established by Rogers and Vismara.

Reichow and Wolery (2009) also considered the strength of the effects of the Lovaas model studies and conducted a formal meta-analysis. Children with autism who received 2 to 4 years of more than 30 hr per week of treatment made very impressive gains (e.g., in IQ, language, and adaptive functioning), with up to 50% achieving scores in the average range. However, Reichow and Wolery suggested that, beyond an unknown minimum intensity in the Lovaas model of intervention, fidelity of treatment may be more crucial than treatment hours.

Evidence of the benefits of intensive ABA-based treatment for children with autism has led to broad implementation of public early intensive behavior intervention programs. Still, relatively few researchers have examined the translation of evidence-based intervention into widespread community practice. The ability to conduct community-based randomized controlled trials, generally considered the gold standard for treatment research, has been limited by many factors (Reichow & Wolery, 2009; Rogers & Vismara, 2008). Among these is the widespread parental perception that only the Lovaas model treatment can produce dramatic results during the narrow preschool window (e.g., Freeman, 2003). Consequently, several studies, including some that have shown benefits of community-based early intensive behavior intervention, are compromised by parents' self-selection into the early intensive behavior intervention group (Cohen, Amerine-Dickens, & Smith, 2006; Hosard, Sparkman, Cohen, Green, & Stanislaw, 2005; Magiati, Charman, & Howlin, 2007). Parent preference appears to have played a smaller role in a recent 2-year outcome study in the United Kingdom in which Remington et al. (2007) found robust differences that favored early intensive behavior intervention over "usual care." However, in several other studies, researchers found that early intensive behavior intervention provided in the community (either through parent-funded private contractors or by public programs) actually yielded minimal benefit (e.g., Bibby, Eikeseth, Martin, Mudford, & Reeves, 2002; Magiati et al., 2007; Smith, Buch, & Gamby, 2000).

The largest community-based study conducted to date does provide evidence for positive outcomes of early intensive behavior intervention (Perry et al., 2008). In this retrospective study, the investigators capitalized on data from intake and exit assessments carried out between 2000 and 2006 within a province-wide intensive behavior intervention program in Ontario, Canada (n = 332, about one third of the children in the program). The sample was treated for a mean of about 18 months. Children demonstrated significant improvements on measures of autism severity and adaptive behavior. Estimated IQs (available for 38% of the sample) increased by a mean of 12 points, and developmental rates (difference between adaptive behavior age equivalents at intake and exit, divided by duration of treatment) doubled during intervention. Outcomes for the highest functioning subgroup at intake were impressive: a mean IQ increase of 21 points and an 18-point gain in Vineland Adaptive Behavior Scale (VABS) Communication standard scores (Perry et al., 2008).

Still, much remains to be discovered about which intervention models most benefit which children (Howlin, Magiati, & Chapman, 2009; Lord et al., 2005; Ospina et al., 2008; Reichow & Wolery, 2009; Rogers & Vismara, 2008). The dearth in the literature of alternative models of service provision, despite the widespread call for cost-effective treatment, is striking. The emphasis in the Lovaas model on initial discrete trial training methods and on long periods of intensive one-to-one teaching (Lovaas & Smith, 2003) means that this form of treatment involves considerable costs (Jacobson, Mulick, & Green, 1998; Senate Standing Committee on Social Affairs, Science and Technology, 2007). Moreover, concerns such as limited social initiations and generalization of children's learning, questionable maintenance of treatment effects, as well as suitability for more mildly affected children have been expressed regarding programs that are predominantly based on discrete trial training (Schreibman, 2000; Rogers & Vismara, 2008). The incorporation of more naturalistic teaching procedures into some early intensive behavior intervention programs has partially addressed these concerns. Nonetheless, many ABA-based programs adhere to the overall structure and intensity of the Lovaas model as well as to the initial (or predominant) use of discrete trial training for most if not all children.

Parent training has been recommended as an important component of effective interventions for autism (e.g., National Research Council, 2001). Parent training can enhance generalization of skills to the child's natural environment as well as maintenance of treatment effects by increasing the likelihood that intervention will be carried over into daily routines (Schreibman & Koegel, 2005). In one randomized controlled trials of a Lovaas-model program, parent involvement was reported to be positively related to child outcomes (Sallows & Graupner, 2005), but no details were provided on parent involvement or on the program's impact on families. Using several randomized controlled trials, researchers have evaluated other, parent-mediated, early intervention programs for autism (Aldred, Green, & Adams, 2004; Jocelyn, Casiro, Beattie, Bow, & Kneisz, 1998; McConachie, Randle, Hammal, & LeCouteur, 2005). In general, these studies have been focused on the growth of key social and communication skills over shorter terms (following children for 3 to 12 months) than most randomized controlled trials of comprehensive early intensive behavior intervention programs. Modest gains have been reported on language or communication (Aldred et al., 2004; Jocelyn et al., 1998; McConachie et al., 2005) and social (Aldred et al., 2004) measures, but with no significant impact on child behavior problems (McConachie et al., 2005). In a recent promising pre-/post-evaluation of a parent-implemented ABA-based intervention, 72 preschoolers with autism showed gains, after 3 months, of 8 and almost 6 months on measures on cognitive and adaptive functioning, respectively (Anan, Warner, McGillivary, Chong, & Hines, 2008).

Thus, traditional early intensive behavior intervention is efficacious in rigorous trials (e.g., Sallows & Graupner, 2005), but shows mixed effectiveness as implemented in community settings (e.g., Magiati et al., 2007; Perry et al., 2008). Shorter-term trials of both social–communication (e.g., Aldred et al., 2004; McConachie et al., 2005) and behavioral (Anan et al., 2008; Coolican, Smith, & Bryson, in press) programs delivered via parents are promising, but gains are relatively modest when contrasted with more intensive ABA-based programs. Community-based early intervention providers, who routinely combine elements of various interventions on an ad hoc basis, are often uncertain about the evidence supporting their practices, and lack sufficient training to implement even best practices that they themselves identify as essential (Stahmer, Collings, & Palinkas, 2005). Even when programs are based on treatment methods that produce good outcomes under ideal conditions, challenges for community implementation include availability of qualified personnel, and ongoing staff training, supervision, and retention (Perry et al., 2008). Monitoring of fidelity of treatment is also an issue for autism intervention programs and for treatment research (Howlin et al., 2009; Reichow & Wolery, 2009). These facts raise the question of whether effectiveness can be shown for less costly, more sustainable programs that combine critical elements such as parental involvement, individualized systematic instruction, planning for generalization of skills, and treatment fidelity (Lord et al., 2005; National Research Council, 2001).

The Nova Scotia early intensive behavior intervention (hereafter called the NS EIBI program) for young children with autism was developed to explicitly address the challenge of providing feasible, sustainable, evidence-based intervention that targets core deficits in socialization and communication. The goal of the program is to produce broad-based positive changes for children and their families. In this program, key treatment techniques are drawn from Pivotal Response Treatment–PRT (R. Koegel & Koegel, 2006; R. Koegel, Schreibman et al., 1989), an established intervention according to the National Standards Report (National Autism Center, 2009). PRT is an ABA-based intervention used in natural settings to enhance children's social interaction, communication, and other adaptive abilities. Highly motivating activities based on the child's own interests as well as natural reinforcers provide the child with learning opportunities. PRT involves no set curriculum but has a developmental orientation (R. Koegel & Koegel, 2006) and manualized procedures (R. Koegel, Schreibman, et al., 1989). Critically, PRT promotes children's initiation of social–communicative acts rather than only their ability to respond to the communication bids of others (R. Koegel, Koegel, Shoshan, & McNerney, 1999; R. Koegel, Vernon, & Koegel, 2009), the latter considered a weakness of discrete trial training-based programs. Skills taught using PRT show greater *generalization* (i.e., skills are more readily applied across social partners and situations (R. Koegel, Koegel, & O'Neill, 1989). *Collateral benefits* of PRT (i.e., improvements in skills that were not specifically targeted) have also been demonstrated (e.g., R. Koegel, Koegel, Hurley, & Frea, 1992). Parent training, an essential component of PRT (Schreibman & Koegel, 2005), can be achieved in a relatively brief time (Coolican, Smith, & Bryson, in press; Openden, 2005). By combining parent- and provider-implemented intervention, programs may maximize treatment hours, thereby optimizing effects while constraining costs.

The NS EIBI model translates PRT from clinic-based applications to a community-based model (Bryson et al., 2007). The associated service delivery model includes parent training and a relatively short period of dedicated provider-implemented, one-to-one intervention, at a maximum of 15 hr per week (compared with the usual 30 to 40 hr per week of the Lovaas model early intensive behavior intervention). PRT is the primary treatment modality, with positive behavior supports (L. Koegel, Koegel, & Dunlap, 1996) as supplementary strategies. Our purpose in the present study is to provide evidence of the effectiveness of the initial implementation of the NS EIBI program.

Method

Participants

Participants were children who were enrolled in the new NS EIBI program in its first 2 years of operation. These 53 preschool-age children were diagnosed with autism based on clinical judgment using Autism Diagnostic Observation Schedule, Autism Diagnostic Interview-Revised, and *Diagnostic and Statistical Manual*-IV-TR criteria. Community clinical teams, independent of the researchers, conducted diagnostic assessments. Participants were selected for this program from the pool of eligible children in each of three geographic areas, also independent of the researchers. Eligibility was determined only by a child's autism diagnosis and age (under 6 years). Table 1 summarizes differences between the selection and treatment of the first two groups of families to receive services in the new model. The initial cohort refers to the first group of families who received training in PRT through workshops conducted by a team from the Koegel Autism Center, University of California at Santa Barbara (UCSB), in August through October 2005 (see Bryson et al., 2007). The second cohort refers to families from the same geographic areas whose children were selected in the second round of program implementation. Initial cohort children were selected quasi-randomly by the lead clinician in each area, with constraints to ensure a wide age and communication ability range (for training purposes). These children received one-to-one provider-implemented intervention for up to 15 hr per week for 12 months.

For the second cohort, selection was random, with participants drawn from pools of eligible children, separately and equally for those under and over the age of 4 years. Random selection was conducted for and by the clinical service, not the research team, to address resource limitations

Table 1. Summary of Selection, Training, and Intervention by Cohort

Cohort	*n* (boys)	Selection	Parent training provider	One-to-one intervention phase	CA at start (in months)		MA at start (in months)		Ratio IQ at start	
					Mean	*SD*	Mean	*SD*	Mean	*SD*
Initial	25 (22)	Random	UCSB[a]	15 hr/week for 12 months	52.0	9.9[b]	24.9	9.9[c]	48.5	19.8[d]
Second	28 (25)	Random: half under and half over 4 years	Local trainers	6 months @ 15 hr/week; 3 months @10 hr/week; 3 months @5 hr/week	48.3	10.1[b]	27.8	10.3[c]	58.8	19.9[d]
Total	53 (47)	–	–	–	50.1	10	26.4	10.1	54.0	20.3
12-month data	45 (39)	–	–	–	49.6	9.8	26.8	10.2	55.2	20.5

[a]University of California, Santa Barbara. [b]Chronological age did not differ between cohorts. [c]Mental age did not differ between cohorts. [d]Ratio IQ_estimated ratio: (MA/CA) × 100); trend, initial cohort > second cohort, $F(1, 51) = 3.52$, $p = .07$.

equitably as an alternative to a waiting list strategy (a decision made in consultation with a bioethicist). The second cohort families were trained by local (Nova Scotia) trainers (who were trained by the UCSB team) starting in September 2006. The one-to-one intensive (15 hr per week) intervention phase for these children was 6 rather than 12 months. This was followed by tapered hours of therapy over the subsequent 6 months (up to 10 hr per week for 3 months, then 5 to 6 hr), a change determined by the clinical service. All parents were approached regarding research participation after accepting the intervention program for their children.

Table 1 also summarizes characteristics of each group of child participants. From a total of 59 children originally enrolled in the NS EIBI program, there were 53 research participants (from 51 families; 2 families each had 2 preschoolers with autism). No data are available regarding the 6 families whose children were enrolled in NS EIBI who did not consent to research participation. The 53 participants ranged in age from 2.08 to 6.0 years at the beginning of treatment, defined here as the first day of parent training. One-to-one interventionists usually began their work with the child following parent training; there were a few instances in which parent training was delayed by 1 to 2 weeks. Eight children were lost from the study after the 6-month assessment point, either because the families withdrew from the clinical program or research contact was lost. Two other families (from the second cohort) elected not to receive direct NS EIBI services beyond 6 months but remained in the study. Thus, 45 of 53 original participants (84.9% of those who entered the study, from 44 families) completed 12-month research assessments.

Measures

The primary target of the PRT-based NS EIBI treatment model is verbal communication. We chose measures of language/communication as well as of cognitive ability to maximize the likelihood of the same measures being applicable across time points, given the large variation in ability of preschool-age children with autism.

Language/communication. The primary language measure was the Preschool Language Scale, 4th ed. (Zimmerman, Steiner, & Pond, 2002), which yields estimates of both receptive and expressive language. Age equivalent (AE) scores are presented for all measures outlined here. Parents completed the MacArthur Communicative Development Inventory (Fenson et al., 1993) for those children who had little or no speech. We used the Peabody Picture Vocabulary Test, 3rd ed.–PPVT III (Dunn & Dunn, 1997) as a supplementary measure of comprehension for children who had a pointing response. Receptive Language subscale AE scores on the Merrill-Palmer-Revised (Roid & Sampers, 2004; see below) provided an additional comprehension measure.

Communication skills (as distinct from formal language) were assessed via parent report on the Communication domain of the VABS II (Sparrow, Cicchetti, & Balla, 2005). This test also provides separate subscales for Receptive and Expressive Communication, for which AE scores are reported.

Cognitive ability. The measure of intellectual ability was the Merrill-Palmer-Revised Scales of Development. The original Merrill-Palmer Scale of Mental Tests (Stutsman, 1931) was a popular measure of nonverbal ability for children with autism. However, the revised test is a comprehensive cognitive measure that differs substantially from its predecessor in content and materials. The Developmental Index (DI) resulting from administration of the Merrill-Palmer-Revised is a general index (comparable to an IQ); it is comprised of subtests measuring cognition, fine motor, and receptive language abilities. These core subtests were administered to all children, and we used DI AE scores for the present analyses. Correlations of .92 and .94 are reported for Merrill-Palmer-Revised DI and Mental Scale scores from the Bayley Scales of Infant Development, 2nd edition, and Brief IQ of the Leiter International Performance Scale-Revised, respectively (Roid & Sampers, 2004).

Adaptive behavior. We assessed adaptive behavior via the Survey Form of the VABS II, which was administered to parents (usually mothers) by trained interviewers. The overall Adaptive Behavior Composite (ABC) score, for children under 6 years of age, is composed of Communication, Socialization, Daily Living, and Motor domains. VABS II AE scores were used (Thurm, Lord, Lee, & Newschaffer, 2007) for subdomains.

In order to maximize the data available for measurement of each child outcome, we used hierarchies of cognitive and language measures (cf. Anderson et al., 2007; Magiati et al., 2007); Preschool Language Scale scores when available as measures of expressive and receptive language. (For those children who reached ceiling on the Preschool Language Scale–4 during the course of the study [$n = 6$ and 10 at the 6- and 12-month assessments, respectively], the mean of the AEs for the PPVT III and VABS Receptive Communication were used instead of the Preschool Language Scale–4 AEs.) When scores were not available, we estimated expressive language using VABS Expressive subdomain AE scores and Receptive Language, by the mean of AE scores on the PPVT III and VABS Receptive subdomain.

We chose the Merrill-Palmer-Revised as the preferred score for children functioning within the wide developmental range typical of preschoolers with autism. Either the Merrill-Palmer-Revised DI, a standard score with a mean of 100 and *SD* of 15, or a ratio IQ estimate based on Merrill-Palmer-Revised DI AE, divided by chronological age (CA) and multiplied by 100 was used as the IQ estimate. Because 9 children were unable to obtain a valid baseline score on this instrument, no direct measure of cognitive ability was available at the beginning of the intervention. For these children, we estimated the ratio IQ by the mean of the following VABS II AE scores: Receptive Language subscale; Personal, Domestic, and Community Daily Living subscales; and Fine Motor subscale, divided by CA and multiplied by 100. We selected these VABS scores as most closely approximating the skills tapped by the Merrill-Palmer-Revised DI.

Autism symptoms. The Social Responsiveness Scale (Constantino & Gruber, 2005) is a 65-item parent-completed questionnaire designed to identify the extent of autistic social impairment. This scale is used to assess social awareness, social information processing, capacity for reciprocal social communication, social anxiety/avoidance, and autistic preoccupations and traits. Although developed for use with older children, some evidence shows that the Social Responsiveness Scale is a reliable index of autism symptoms in preschoolers (Pine, Luby, Abbacchi, & Constantino, 2006).

Behavioral problems. The Child Behavior Checklist, Ages 1½-5–CBCL (Achenbach & Rescorla, 2000) is a commonly employed, reliable, and valid measure of children's internalizing and externalizing behaviors. Parents rate 99 problem items on a 3-point scale based on how true they are of the child. The CBCL yields T scores (normative $M = 50$, $SD = 10$). We used the Total

Problems, Internalizing Problems, and Externalizing Problems scales and the Aggressive Behavioral subscale in the present analyses.

Parent measures. Parents also reported on their own stress related to their experiences as parents, using the Parenting Stress Index–Short Form (Abidin, 1995); results from this and other measures (e.g., parental satisfaction with treatment program, qualitative measure of parental perceptions of children's progress) will be reported in another paper.

Intervention

Children received intervention based on PRT (R. Koegel, Schreibman et al., 1989) and positive behavior support (L. Koegel et al., 1996), according to the model described by Bryson et al. (2007). There were differences in the provision of intervention for the initial and second cohorts (see Table 1 for summary). First, the mode of parent training differed. Initial cohort parents and early intensive behavior intervention staff members attended a group workshop (Openden, 2005) in which the rationale and fundamental techniques of PRT were taught in the context of hands-on practice with their own children. Trainers used videorecordings of practice sessions to provide individualized feedback to parents. Beginning with the second cohort, subsequent families were trained in vivo in their homes by local clinicians who had been trained both in PRT techniques and how to conduct parent training by consultants from UCSB. Following the one-week parent training period (whether in a group workshop or individually at home), therapy was provided for all children by one-to-one interventionists in the home and/or at daycare/preschool. For both cohorts, the first 6 months of therapy consisted of up to 15 hr per week by the interventionists. However, after the first year of the program, direct treatment hours were reduced as outlined above. Fidelity of treatment implementation was monitored by staff from the clinical program (which will be presented in a subsequent paper). Almost all of the interventionists (86.6%) met the UCSB team's criteria for fidelity of PRT implementation ($>$ 80% on six key procedures, as described by Bryson et al., 2007) within the first 3 to 4 months of working with their initial child in treatment. The NS EIBI model was explicitly designed to encourage parents' use of PRT. For all families, one-to-one treatment was supplemented by parents' use of the techniques in everyday routines. Although parents reported on a program satisfaction questionnaire that they were comfortable using PRT techniques, we did not gather objective data at this early stage of the study to validate these reports. (This issue will be addressed in a later paper.)

From the outset, interventionists used PRT techniques to teach every child. That is, although the intervention is based on ABA principles, there was no initial period of discrete trial training as in traditional (i.e., the Lovaas model) early intensive behavior intervention (Lovaas & Smith, 2003). Consistent with other applications of PRT, intervention did not follow a curriculum (cf. Rogers & Vismara, 2008). Instead, each child's intervention team, including a clinical supervisor (a psychologist or occupational therapist), speech–language pathologist, interventionist, and parents, developed individual goals with an emphasis on functional communication and developmentally appropriate skills, accomplished in the context of play and other functional daily routines. All teaching took place within naturalistic interactions. Children's motivation to communicate was maximized by following their preferred activities or giving them choices, using natural reinforcers and other empirically validated PRT techniques (see R. Koegel & Koegel, 2006).

Of the 45 children, 43 were enrolled in an early childhood education program (daycare or preschool), either full or part time, at some point during the period of NS EIBI involvement. These inclusive programs typically provided eclectic supports for children with special needs (including autism), such as use of visual schedules and other teaching adaptations as well as individualized staffing. NS EIBI interventionists supported the child in these settings to whatever degree was appropriate given the child's level of functioning, with the overall goal of facilitating social and communicative interactions with both adults and peers. These supports included teaching PRT and positive behavior support strategies to early childhood educators and/or developing behavior programs to address specific skill deficits or maladaptive behaviors.

Other interventions. Prior to being offered NS EIBI, most families had completed the Hanen More Than Words parent-mediated program (Sussman, 1999), which is offered through Nova Scotia's public speech–language services to children who are suspected of having autism. Parents had agreed, as part of the early implementation of the NS EIBI program, to abstain from other, privately funded autism-specific interventions.

Procedure

We conducted baseline (Time 1) assessments as close as possible to the start of intervention (i.e., first day of parent training). Five children had scores from participation in another study, from tests administered a mean of 85 days prior to this intervention. For the 48 remaining children, testing took place a mean of 20 days (SD = 19.9) following parent training, yielding conservative estimates of change. Research examiners who were experienced in testing young children with autism conducted assessments independent of the intervention service. Most testing took place in a clinical research setting; otherwise, tests were given in a quiet space in the child's home or other community setting (e.g., preschool). Subsequent assessments took place approximately 6 months (M = 6.8 months, SD = 22.0 days) and 12 months (M = 13.4 months, SD = 42.7 days) after the start of intervention. Twenty-six of the 45 children (57.8%) entered school immediately prior to the 12-month assessment (i.e., within 1 to 2 months). Questionnaires were mailed to parents and returned either by mail or at assessment sessions.

Results

We conducted analyses using SPSS Version 15. Most outcome analyses consisted of repeated-measures ANOVAs for each dependent variable, with the within-subjects variable, time, measured at the start of NS EIBI and after 6 months and 12 months of treatment.

Analyses by Cohort and Time

The cohorts differed in several ways, both as outlined above and including a trend toward lower baseline IQs for the initial cohort (see Table 1) and for the 45 children who completed 12 months of NS EIBI (Ms = 51.1, SD = 19.3, and 58.8, SD = 21.3, for the initial and second cohorts respectively), $F(1, 43) = 3.63$, $p = .06$, partial $\eta_p^2 = .08$. Therefore, in preliminary analyses we compared the two cohorts on the primary outcomes, language and communication scores, as well as on cognitive and behavior measures. The results of these analyses are summarized in Table 2. For each of these dependent variables, we conducted a mixed 3 (Time: start, 6, and 12 months) $\times$ 2 (Cohort: initial and second) ANCOVA on the relevant AE scores, with start IQ as the covariate. These analyses revealed no significant main effects of cohort or time, and no significant Time $\times$ Cohort interactions (values of η_p^2 ranging from .00 to .06). In contrast, in each analysis the effect of the covariate, start IQ, was significant, with values of η_p^2 ranging from .35 to .60. All Time $\times$ Start IQ interactions were also significant, although effects were more modest, η_p^2 from .11 to .26. Thus, these initial analyses showed that cohort had no effects on children's outcomes. They also demonstrated that, as expected, children's IQ at the start of NS EIBI had a very large effect on gains at 12 months. Given these effects and large within-group variability, we conducted subsequent analyses on two more homogeneous groups defined in terms of start IQ.

Analyses by Time and IQ Category

Results that follow combine data from both cohorts and include IQ category as a between-subjects variable to illustrate the large impact of start IQ on growth during the intervention. Consistent with this strategy, most results are illustrated here separately for lower ($<$ 50) and higher ($\geq$ 50) start IQ groups. An estimated IQ of 50 was used as the cutoff point based on test convention (although this value was also close to the group median start IQ of 52.8). We acknowledge that treatment of IQ as a dichotomous rather than continuous variable results in a loss of power and, thus, a conservative bias (i.e., against showing significant IQ Category $\times$ Time interactions. When IQ Category $\times$ Time interactions were significant, we examined simple effects using one-way ANOVAs, followed by post hoc pair-wise comparisons (with Bonferroni correction).

Language/communication. Consistent with the communicative emphasis of this PRT-based program, we considered language and functional communication to be the primary outcomes. As outlined above, the Preschool Language Scale was the most appropriate comprehensive language measure for this age group; best estimate expressive and receptive language AEs were taken to be the Preschool Language Scale Expressive Communication and Auditory Comprehension subscale AE scores, when available. If these Preschool

Table 2. Separate Repeated Measures ANCOVAs by Cohort and Time

	Between-subjects				Within-subjects		Interaction			
	Cohort		Start IQ[a]		Time		Time × Cohort		Time × Start IQ	
Dependent variable	$F(1)$	η_p^2	$F(1)$	η_p^2	$F(2)$	η_p^2	$F(2)$	η_p^2	$F(2)$	η_p^2
Expressive Language[a] AE[b]	.00	.00	40.89***	.49	.29	.01	.81	.02	11.39***	.21
Error (mean square)	42 (277.33)				84 (22.58)					
Receptive Language[a] AE	.30	.01	43.35***	.51	.44	.01	.04	.00	10.28***	.20
Error (mean square)	42 (430.48)				84 (55.92)					
Expressive Communication[c] AE	.07	.00	23.08***	.38	.91	.02	.50	.01	4.90*	,11
Error (mean square)	38 (316.71)				76 (25.29)					
Receptive Communication[c] AE	.25	.01	20.82***	.35	.48	.01	2.00	.05	13.63***	.26
Error(mean square)	38 (472.67)				76 (85.93)					
Cognitive[d] AE	.33	.01	63.47**	.60	.91	.02	2.72	.06	6.52**	.13
Error (mean square)	42 (248.68)				84 (51.13)					
Behavioral Problems[e]	.37	.01	.10	.00	1.04	.03	.51	.02	.68	.02
Error (mean square)	33 (246.33)				66 (28.63)					
Autism symptoms[f]	.76	.02	.37	.01	.98	.03	.38	.01	3.87*	.11
Error (mean square)	33 (337.03)				66 (76.85)					

[a]Estimated. [b]Age equivalent. [c]Vineland Adaptive Behavior Scales-II. [d]Best estimate. [e]Child Behavior Checklist. [f]Social Responsiveness Scale.
$*p < .05$. $**p < .01$. $***p < .0001$.

Language Scale scores were not available (no basal or ceiling established), we estimated expressive language from the VABS Expressive Communication subscale and Receptive Language, by the combined PPVT III and Vineland Receptive Communication subscale AE scores.

Expressive language. Figure 1 shows these best-estimate Expressive Language AE scores at start, 6, and 12 months for the two groups defined by ratio IQs at the beginning of treatment. A mixed 3 (Time: start, 6, and 12 months) × 2 (IQ Category: lower and higher) ANOVA conducted on these data revealed the expected significant main effect of IQ category, $F(1, 43) = 21.61$, $p < .0001$, $\eta_p^2 = .33$, as well as a significant main effect of time, $F(2, 43) = 72.48$, $p < .0001$, $\eta_p^2 = .63$. Pair-wise contrasts showed that 12-month scores were greater than those at 6 months, and 6-month scores were greater than those at start, $ps < .0001$. There was also a significant Time × IQ Category interaction, $F(2, 86) = 12.72$, $p < .0001$, $\eta_p^2 = .23$. For scores of both the lower and higher IQ groups, one-way ANOVAs indicated main effects of time (lower: $F(2, 17) = 12.9$, $p = .001$, $\eta_p^2 = .45$; higher: $F(2, 27) = 84.6$, $p < .0001$, $\eta_p^2 = .76$), and contrasts indicated that all scores differed from each other (i.e. that is, both groups made significant gains after both 6 and 12 months of intervention. However, the significant Time × IQ Category interaction reflects the steeper slope of change for the higher IQ group.

Receptive language. A parallel analysis conducted on best-estimate Receptive Language AE scores (also shown in Figure 1) revealed a similar pattern. In addition to the significant main effect of IQ category, $F(1, 43) = 41.03$, $p < .0001$, $\eta_p^2 = .49$, there was a significant main effect of time, $F(2, 43) = 9.69$, $p < .0001$, $\eta_p^2 = .18$, and a significant Time× IQ Category interaction, $F(2, 86) = 6.42$, $p = .003$, $\eta_p^2 = .13$. That is, both the lower and higher IQ groups showed language comprehension gains over time (main effects of time for lower IQ: $F(2, 32) = 10.43$, $p = .002$, $\eta_p^2 = .40$; higher IQ: $F(2, 54) = 41.1$, $p < .0001$, $\eta_p^2 = .60$, and contrasts indicated that all scores differed from each other (ps ranged from .04 for scores in lower IQ group to $< .0001$ for higher IQ group scores). Thus, children with higher IQs when treatment began made greater gains in both expressive and receptive language. However, both

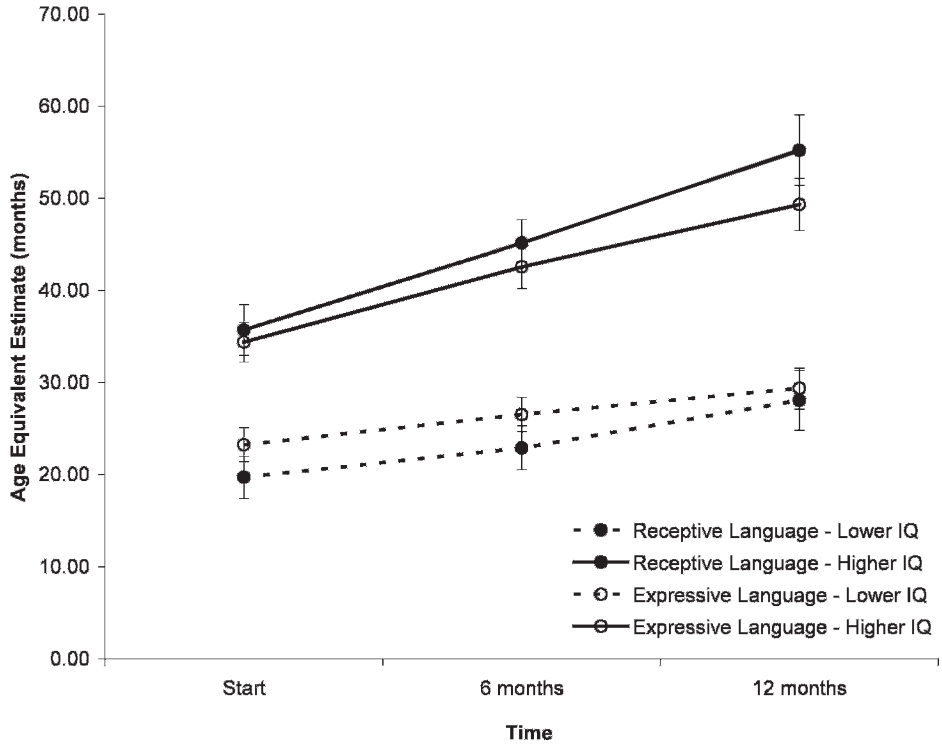

Figure 1. Mean estimated scores (age equivalents in months, with standard errors) for receptive and expressive language abilities, at Nova Scotia early intensive behavior intervention (NS EIBI) start and 6 and 12 months later for groups with higher IQ and lower IQ at NS EIBI start and for the total sample.

groups showed significant increases in mean scores by 6 months and again after 12 months of intervention. These amounted to one-year mean AE gains of 6.1 and 8.4 months for expressive and receptive language, respectively, for the lower IQ group and 14.9 and 19.5 months, respectively, for the higher IQ group.

Noting the similar patterns of increases seen in Figure 1 for receptive and expressive language AE scores, we computed correlations between individuals' scores on these variables at each time point. Strong (and possibly increasing) relationships were evident between receptive and expressive language scores: rs(45) = .84, .91, and .93 at start, 6, and 12 months, respectively, all ps $< .0001$.

Expressive and receptive communication. We derived measures of more functional communication from parent report on the VABS II Expressive and Receptive subscale AE scores; these showed a similar pattern to the direct measures of child skills (see Table 3). Analyses of these scores again reveal main effects of IQ category (expressive $F[1, 39] = 14.66$, $p < .0001$, $\eta_p^2 = .27$; receptive $F[1, 39] = 25.60$, $p < .0001$, partial $\eta_p^2 = .40$), and time (expressive $F[2, 78] = 64.71$, $p < .0001$, $\eta_p^2 = .62$; receptive $F[2, 78] = 50.07$, $p < .0001$, $\eta_p^2 = .56$). Contrasts indicate that 6-month scores were greater than those at start, $p = .01$, and that 12-month scores were greater than 6-month scores, $p < .001$. However, there were also significant IQ Category × Time interactions (expressive $F[2, 78] = 3.15$, $p < .05$, $\eta_p^2 = .08$; receptive $F[2, 78] = 14.29$, $p < .0001$, $\eta_p^2 = .27$). For the lower IQ group's VABS Expressive AE scores, there was a simple main effect for time, $F(2, 24) = 16.10$, $p < .0001$, $\eta_p^2 = .57$, with pair-wise post hoc contrasts indicating that start scores were significantly less, $p = .002$, than either 6- or 12-month scores (which did not differ but showed a trend, $p = .06$, toward higher 12-month scores). The pattern of receptive AE scores for the lower IQ group is clearer, time $F(2, 24) = 8.98$, $p = .003$, $\eta_p^2 = .43$. Contrasts indicate that 12-month scores were significantly higher, $p = .01$, than were either start or 6-month scores, which did not differ, $p = 1.00$.

For the higher IQ group's VABS Expressive AE scores, time, $F(2, 54) = 72.59$, $p < .0001$, $\eta_p^2 = .43. = .73$, and contrasts indicate that 12-month scores were greater than 6-month scores, which were greater than start scores, ps $< .001$. Receptive Communication AE scores for the higher IQ group also showed these effects, time $F(2, 54) = 74.56$, $p < .0001$, $\eta_p^2 = .43. = .73$; 12-month scores were greater than 6-month scores, $p < .0001$, which were greater than start scores, $p = .001$. Thus, significant gains were reported by parents for both expressive and receptive communication for the higher IQ group within 6 months, but evidence of receptive skill growth was delayed in the lower IQ group.

Adaptive behavior. Modest growth was seen in adaptive behavior, as reflected in VABS II standard scores for each domain (Communication, Socialization, Daily Living, and Motor Skills) and Adaptive Behavior Composites at start and after 6 and 12 months of intervention for lower (Figure 2) and higher (Figure 3) IQ groups (shown separately for clarity). Repeated measures ANOVAs for each of these within-subject variables (at start, 6, and 12 months, with IQ category as the between-subject variable–see Table 4) all show main effects of time and of IQ category. Contrasts for time suggest that scores were higher

Table 3. Scores for Expressive and Receptive Communication Subscales of the VABS-II by Time and IQ at Start of Nova Scotia Early Intensive Behavior Intervention

	Start		6 months		12 months	
Age equivalent scores	Mean	*SD*	Mean	*SD*	Mean	*SD*
Expressive communication						
Lower IQ	20.5	8.5[a]	25.6	7.7[b]	31.0	14.0[b]
Higher IQ	31.7	10.4[c]	40.1	12.4[d]	48.1	14.4[e]
Receptive communication						
Lower IQ	21.1	13.7[a]	23.2	8.9[a]	31.0	12.4[b]
Higher IQ	31.6	10.2[c]	42.0	13.8[d]	64.8	20.7[e]

Note. Superscripts indicate, across rows, values that do or do not differ significantly. VABS-II = Vineland Adaptive Behavior Scale (2nd ed.).

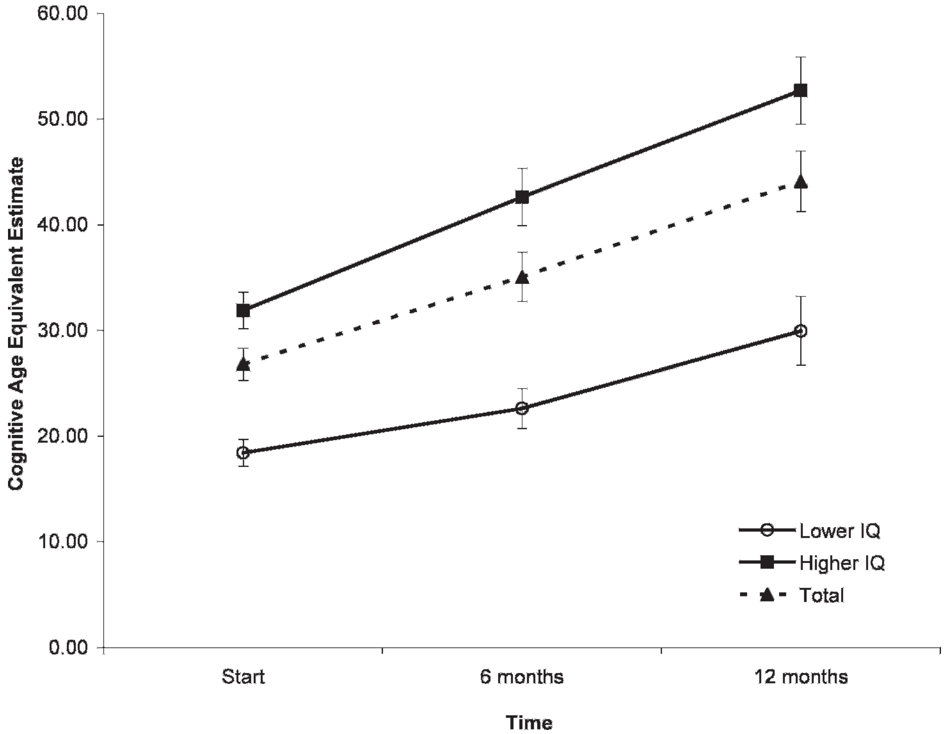

Figure 2. Mean estimated scores (age equivalents in months, with standard errors) for cognitive ability, at Nova Scotia early intensive behavior intervention (NS EIBI) start and 6 and 12 months later for groups with higher IQ and lower IQ at NS EIBI start and for the total sample.

at 12 months than at 6 months, which did not differ from start scores. Despite the nonsignificant Time × IQ Category interactions, inspection of Figures 2 and 3 suggests that the lower IQ group did not show change prior to 6 months, whereas growth was evident from start to 6 months for the higher IQ group.

Cognitive abilities. We also analyzed cognitive AE scores in a mixed (Time × IQ Category) ANOVA; results are shown in Figure 4. The main effects of both time, $F(2, 86) = 67.28$, $p < .0001$, $\eta_p^2 = .61$, and IQ category, $F(1, 43) = 29.58$, $p < .001$, $\eta_p^2 = .41$, were significant, as was the Time × IQ Category interaction, $F(2, 86) = 5.85$, $p = .008$, $\eta_p^2 = .12$. Contrasts indicate that 12-month scores were greater than 6-month scores, $p < .001$, which in turn were higher than start scores, $p < .001$, with the difference between lower and higher IQ groups evident between start and 6 months, $p = .006$. This indicates greater gains in the first 6 months of intervention for the higher versus the lower IQ group.

Developmental rates. Children's cognitive outcomes at 12 months were also examined in relation to typical time-appropriate gains (i.e., we calculated ratios expressing increases in AE scores divided by actual time between test administrations. A ratio of 1.00, therefore, represents a typical developmental rate, and ratios greater than 1.00 represent greater than expected gains.) For the 45 children who completed 12 months of treatment, the mean ratio for cognitive AE scores was 1.38 ($SD = .95$). Thirty children (66.7%) had rates exceeding 1.00, and of these, 11 (24.4% of total) were greater than 2.00 (i.e., they showed cognitive progress at double the rate seen in typical development). For comparison with other studies, we also examined these accelerations in overall development with reference to gains on ratio IQs. The overall mean IQ gain was 16.4 points ($SD = 18.4$); 18 of 45 children (40%) achieved ratio IQs above 85 at 12 months (compared with 4 of 53, or 7.5% of the children at NS EIBI start).

Behavioral problems. As seen in Figure 3, there was a main effect of time for CBCL Total Problems *T* scores, $F(2, 68) = 15.29$, $p < .0001$, $\eta_p^2 = .31$. Pair-wise contrasts indicated that scores at start were significantly higher, $p < .001$, than those at 6 or 12 months, which did not differ. The

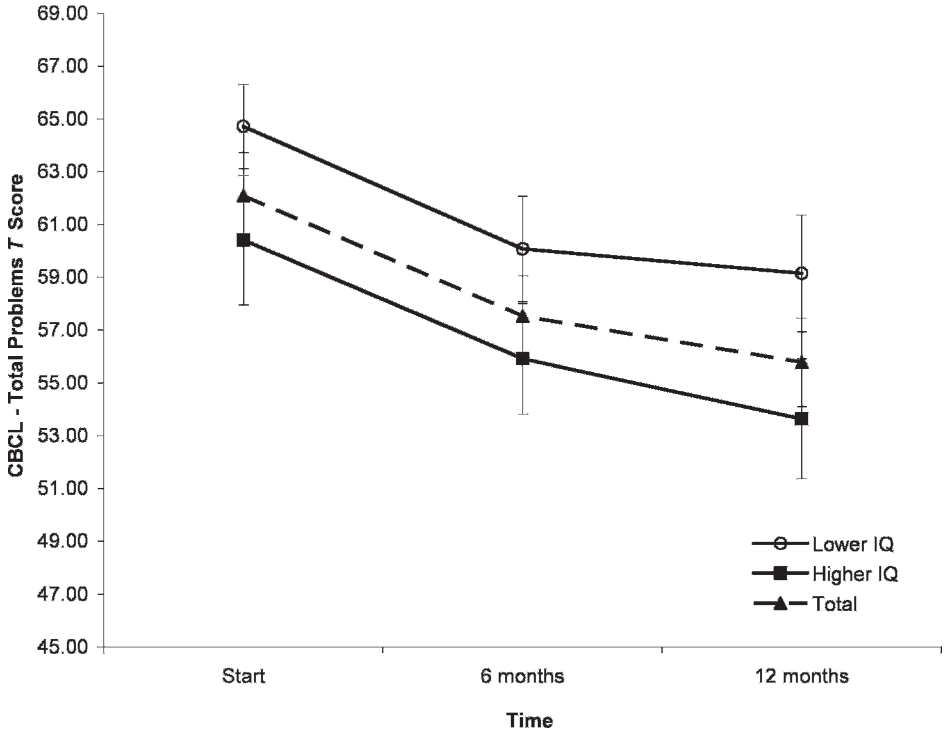

Figure 3. Mean Total Problems *T* scores on the Child Behavior Check List (CBCL), representing children's levels of behavior problems at Nova Scotia early intensive behavior intervention (NS EIBI) start and 6 and 12 months later for groups with higher IQ and lower IQ at NS EIBI start and for the total sample.

main effect of IQ category was not significant nor was there a significant Time × IQ Category interaction. Note, however, that the mean Total Problems score for the higher IQ group declined from the clinically elevated range at start (M = 60.4, SD = 11.5) to within the average range by 6 months (M = 55.9, SD = 9.8), whereas at 12 months the lower IQ group remained at the margin of the elevated range (M = 59.1, SD = 8.3).

Autism symptoms. Total *T* scores on the Social Responsiveness Scale are seen in Figure 4, illustrating a significant main effect of time, $F(2, 68) = 4.42$, $p = .03$, $\eta_p^2 = .12$, a trend toward IQ category differences, $F(1, 34) = 3.42$, $p = .07$, $\eta_p^2 = .09$, and a significant Time × IQ Category interaction, $F(2, 68) = 4.16$, $p = .02$, $\eta_p^2 = .11$. Analyses of simple effects indicate no change in Social Responsiveness Scale Total scores over time for the lower IQ group, whereas for the

Table 4. Separate Repeated Measures ANOVAs for Measure, Time, and Group

	Between-subjects: IQ category		Within-subjects: time		Time × IQ Category interaction	
VABS II[a] domain	$F(1, 39)$	η_p^2	$F(2,78)$	η_p^2	$F(2, 78)$	η_p^2
Communication	33.03**	.46	15.01**	.29	.85	.02
Daily Living Skills			6.98*	.15	1.74	.04
Socialization			.33**	.19	2.59	.06
Motor Skills	5.56*	.13			.04	.00
ABC[b]	14.25**	.27			2.31	.06

[a]Vineland Adaptive Behavior Scales-2nd ed. [b]Adaptive Behavior Composite.
*$p < .01$. **$p < .001$.

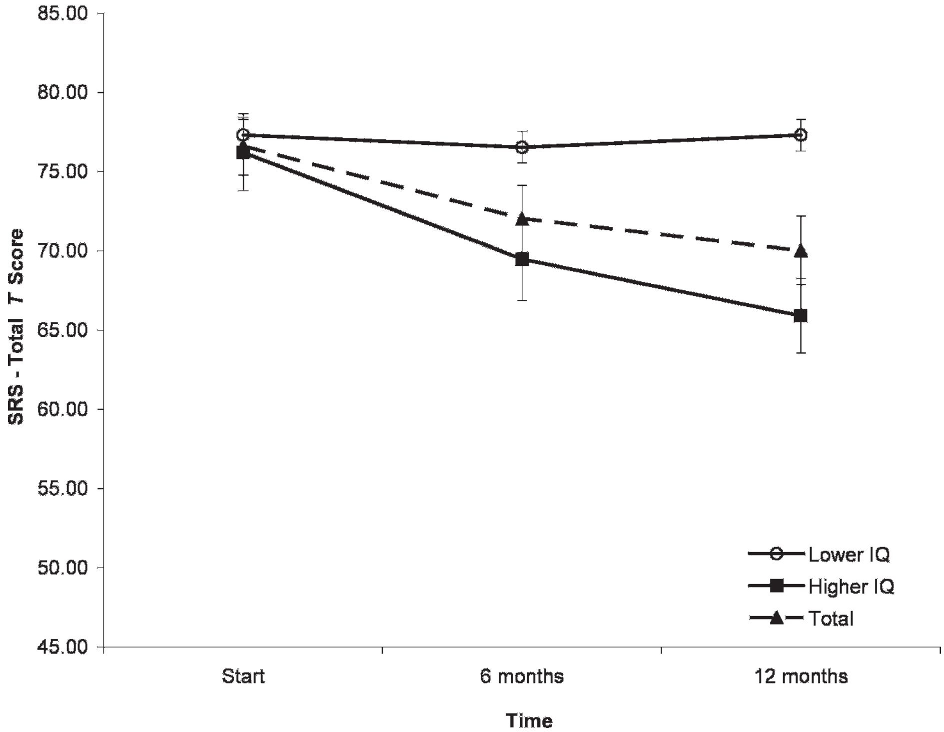

Figure 4. Mean Total *T* scores on the Social Responsiveness Scale (SRS), representing children's levels of autism symptoms at Nova Scotia early intensive behavior intervention (NS EIBI) start and 6 and 12 months later for groups with higher IQ and lower IQ at NS EIBI start and for the total sample.

higher IQ group, autism symptoms declined significantly over time, $F(2, 44) = 10.99$, $p = .001$, $\eta_p^2 = .33$, from start to 6 months, $p = .03$, and from 6 to 12 months, $p = .04$. Particularly noteworthy here is that Social Responsiveness Scale scores at NS EIBI start did not differ significantly between the two groups defined by baseline IQ (lower IQ $M = 77.3$, $SD = 10.2$; higher IQ $M = 76.2$, $SD = 11.7$), $F(1, 47) = .13$, $p = .72$, $\eta_p^2 = .00$). That is, autism symptoms were no more severe at start for the lower IQ than for the higher IQ group, but only those in the latter group decreased significantly across 12 months of intervention. In the higher IQ group, the mean Social Responsiveness Scale Total score declined from 76.2 to 65.9 over 12 months, remaining within the clinical range.

Discussion

These findings indicate that preschool-age children who participated in the community-based NS EIBI program showed accelerated growth across multiple domains of development over one year of intervention. Positive growth was evident not only in language and communication, the main focuses of intervention, but also on measures of cognitive, adaptive behavior, problem behavior, and autism symptoms. The magnitude of these changes compares favorably to gains observed in more intensive programs based on the Lovaas early intervention model. Most important, these outcomes were achieved in a far less costly community-based model that is premised on parental training in addition to a limited period of direct intervention.

In controlled research, up to 50% of children with autism have been reported to benefit enormously from traditional early intensive behavior intervention programs, achieving scores in the average range on standardized measures (Sallows & Graupner, 2005; Smith, Groen, & Wynn, 2000). In comparison, Perry et al. (2008) reported that one quarter of the children in their very large community program achieved outcomes judged successful (11% "average functioning," and a further 15% showing "substantial" improvement), although theirs was a more impaired sample. In the present study, 40% of the children had both IQs and receptive language scores in the average range following 12 months of intervention. It bears emphasizing that the best outcomes reported by, for example, Sallows and Graupner (2005) reflect a mean of 38 hr per week of intervention for 2 years (in their clinic-directed group). In comparison, the community-implemented intensive intervention in Ontario offers 20 to 40 hr each week for an average of 1.5 years, whereas the Nova Scotia program entails a maximum of 15 hr per week of therapist-provided treatment, now gradually reduced after 6 months, for a total of 12 months of direct treatment. However, parent training in PRT is an explicit aspect of the Nova Scotia model, intended to extend therapeutic interactions that specifically promote social interaction and functional communication throughout the child's day. Here, in addition to the presumed amplification of positive effects on children's development, the intent was also to benefit parents by providing them with skills that are readily applied in daily family life. As the NS EIBI program has grown, there is also an increasing emphasis on supporting early childhood educators in their work with children who have autism. Thus, the goal is for others in the child's life to continue promoting social and communication skills after the one-year program. As outlined in Bryson et al. (2007), this program reflects an explicit effort to maximize available resources for effective intervention for as many children as possible (cf. Mannin-Courtney, 2007).

The mean IQ gain observed here (16 points) exceeds the 8 points reported by Eldevik, Eikeseth, Jahr, and Smith (2006), whose 12-hour-per-week early intensive behavior intervention program is perhaps the closest intensity match to the Nova Scotia program. This Norwegian study involved participants who were somewhat lower-functioning, on average, than those in the present sample (*M* intake IQ of 41 vs. 54.0). Indeed, the magnitude of the average IQ increase in our group compares favorably with studies by Cohen et al. (2006)–15 points over 1 year, or Smith, Groen, and Wynn (2000)–16 points in 2 to 3 years. However, both of these research groups used randomized trials; therefore, IQ increases can be interpreted in relation to the minimal gains seen in controls. Without a randomized control group, any claim regarding the significance of developmental gains can be based only on normative expectations derived from standardized test performance. It also bears emphasizing that in the absence of clear treatment effects, substantial IQ changes (over 14 points) have been observed in nearly 10% of young children with autism in one sample (Dietz, Swinkels, Buitelaar, van Daalen, & van Engeland, 2007).

As others have discussed (e.g., Lord et al., 2005; Magiati & Howlin, 2001), the challenges of longitudinal measurement of cognitive and language development in young children with autism are considerable, given the dearth of measures that span the wide range of functioning in this population. In this context, we also note that our clinical experience thus far with the new Merrill-Palmer-Revised suggests that it may be a relatively conservative measure of IQ for preschoolers with autism compared with other commonly used measures, such as the Mullen Scales of Early Learning (Mullen, 1995) or Differential Ability Scales (Elliott, 2007). Our decision to use the new Merrill-Palmer-Revised was based on the appropriateness of its developmental range, the appeal of its materials for this population, and early evidence of reliability and validity (Roid & Sampers, 2004). With respect to observed Merrill-Palmer-Revised DI scores that were lower than our clinical expectations for IQ, we speculate that the absence of a scale that depends heavily on perceptual discrimination abilities (as do, e.g., Visual Reception from the Mullen Scales or Picture Similarities from the Differential Ability Scales) shifts the focus of the Merrill-Palmer-Revised Cognitive Scale to more conceptual problem solving. If true, this suggests that our estimates of children's 12-month outcomes are also conservative (an effect compounded by the lag between the start of treatment and baseline testing).

Another important consideration with respect to our evidence of substantial developmental gains for children in the NS EIBI program is that the present community sample was unselected. Most data from the Lovaas-model early intensive behavior intervention programs have been gathered in the context of research programs or programs provided by private agencies and selected by parents as alternatives to eclectic community programs. The NS EIBI program is the only publicly funded form of autism-specific early intervention in this province (other than the short-term More Than Words), where few private therapy options are available. A few families served by the NS EIBI program (10%) declined research participation. Within the present study sample, 15% of parents either withdrew from the program or were lost to research follow-up. The limited data available suggest that children in this latter (withdrawal) group were not significantly different from the larger participating group and are distinguished only by a suggestion of higher parental distress scores on the Parenting Stress Index. In a subsequent paper we will present these and additional data on child and family functioning within the NS EIBI model, based on a larger sample.

As an example of community-based effectiveness research, this prospective study has unique strengths. As noted earlier, given constrained public resources in implementing the NS EIBI model, children's entry into the program is determined by random selection (a policy decision supported by ethical consultation). Few families declined the program, resulting in a sample representing all levels of child ability and family socioeconomic levels. There are few evaluations of community-based early intervention programs for autism in the literature, and data on refusals and withdrawals are often lacking (perhaps due to use of convenience samples in the nonrandomized controlled trials studies). Fidelity of implementation of treatment methods was monitored by the clinical NS EIBI program, again not universal in the literature (Howlin et al., 2009; Rogers & Vismara, 2008), although details are not available for the present sample. Moreover, the present study entailed comprehensive standardized assessments of children and families conducted by research examiners who were independent of the NS EIBI service.

Another noteworthy aspect of the present program is that the primary target of intervention was children's social and communication skills. Moreover, the emphasis was on functional skills, as opposed, for example, to vocabulary acquired out of context through massed teaching trials. This point is evident in the fact that growth in children's receptive language abilities was at least as great as expressive gains, despite the fact that the intervention (PRT) promoted functional speech (i.e., language comprehension was not an explicit target of the intervention). Similarly, although compliance with adult direction was not targeted, children's enhanced ability to attend and to follow instructions was certainly evident in increased participation in standardized testing as well as in higher test scores.

Limitations

Of course, without controlled trials our outcomes cannot be directly compared to those of other programs. Although the continued need for rigorously managed randomized controlled trials is indisputable, there is now also a strong call to invest in larger-scale effectiveness trials designed to assess the impact of empirically supported treatment delivered to more children and, ideally, to community-based samples (Lord et al., 2005; Rogers & Vismara, 2008). Complementary designs, including those in which participants are unselected (vs. randomized or matched), have been advocated for these purposes (McCall & Green, 2004; Schopler, 2005). What is lacking in the present study is a comparison with children whose families were *not* selected for the early intensive behavior intervention program; we are now gathering such data.

It might also be considered a limitation of the present study that children with the broad range of autistic spectrum disorders were included (rather than those meeting strict autism criteria), but this represents clinical reality. Consistent with ethical considerations regarding access to treatment, eligibility for this publicly funded program is based on any autism spectrum diagnosis; however, we emphasize that diagnostic assessments were carried out by experienced clinical teams using standardized measures.

We acknowledge that interpretation of the present results is complicated by the differences between the two cohorts and their treatment; for example, in the details of methods of selection and intervention intensity in the second 6 months of program participation. No statistically significant differences emerged in analyses that included cohort as a between-subjects variable. However, it is plausible that differences (i.e., the initial cohort was overall lower-functioning and these children received more hours of intervention in the latter 6 months; most intervention team members were more experienced when working with the somewhat higher-functioning second cohort) might have produced opposite effects on outcomes. We cannot rule out the possibility that more hours of intervention in the second 6 months of treatment might have facilitated even greater growth in skills for the second cohort than was evident here.

Our results suggest the possibility that substantial improvements in multiple aspects of functioning may be accomplished for many children with autism in a less intensive, relatively short-term behavior program using methods that are family-friendly. In this model, parents are expected to be neither case managers nor therapists carrying out set teaching programs in specific contexts. Instead, consistent with the goals of many social communication interventions and contemporary applications of ABA, parents learn methods that are readily incorporated into everyday interactions and routines. We do emphasize, however, that the NS EIBI program also relies on highly motivated parents and staff, intensive training and on-going support of treatment teams, interdisciplinary collaboration, and close attention to the individualization of children's programs, all supported at the provincial level by a clinical leader and a clinician network (see Bryson et al., 2007).

As in all autism intervention programs, there remains the important question of how best to serve the children whose gains are less striking on standardized language, cognitive and adaptive behavior measures (Reichow & Wolery, 2009). In the present study, we saw evidence of improved functioning with respect to these abilities as well as significant overall reductions in behavior problems, even in some of the children who were more severely affected. However, the gains were smaller, and there were no significant reductions in autism symptoms for these participants as a group. Parental perceptions of change (to be discussed further in a subsequent paper) suggest that even for the small subset of children whose improvements were negligible on standardized measures, there were important changes in parents' sense of connectedness to their child and in children's awareness of both others and things in their world. These outcomes speak to the continuing challenge of how to define and measure valued outcomes and to match intervention to child (and family) needs and characteristics (Lord et al., 2005; Rogers & Vismara, 2008).

Of course, the potential longer-term benefits associated with the NS EIBI program remain to be demonstrated; follow-up is on-going. Whether programs such as this accelerate the development of some preschoolers with autism enough for them to derive greater benefit from inclusive school programs is an important question. Ideally, resources could then be garnered for more intensive programming that addresses the long-term needs of children with more significant developmental challenges. In addition, future researchers should document the effects of such programs on parent–child relationships and parental self-efficacy. Questions about the goals of intervention, how much intervention should be provided, and for whom, are crucial public policy considerations for which empirical evidence is sorely needed. The present study provides initial evidence supporting the value of investigating alternative, less resource-demanding models of intervention for children with autism.

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