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A comparison of intensive behavior analytic and eclectic treatments for young children with autism

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Abstract

We compared the effects of 3 treatment approaches on preschool-age children with autism spectrum disorders. Twenty-nine children received intensive behavior analytic intervention (IBT; 1:1 adult:child ratio, 25-40 hours per week). A comparison group (n = 16) received intensive "eclectic" intervention (a combination of methods, 1:1 or 1:2 ratio, 30 hours per week) in public special education classrooms (designated the AP group). A second comparison group (GP) comprised 16 children in nonintensive public early intervention programs (a combination of methods, small groups, 15 hours per week). Independent examiners administered standardized tests of cognitive, language, and adaptive skills to children in all 3 groups at intake and about 14 months after treatment began. The groups were similar on key variables at intake. At followup, the IBT group had higher mean standard scores in all skill domains than the AP and GP groups. The differences were statistically significant for all domains except motor skills. There were no statistically significant differences between the mean scores of the AP and GP groups. Learning rates at followup were also substantially higher for children in the IBT group than for either of the other two groups. These findings are consistent with other research showing that IBT is considerably more efficacious than "eclectic" intervention.

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Early intervention targets differences between the skills of children who have or are at risk for developmental delays and the skills of their typically developing peers. Those discrepancies may be small initially but are generally acknowledged to increase with the passage of time (e.g., Guralnick, 1998; Ramey & Ramey, 1998). Developmental trajectories are not fixed, however, even for children with known risk factors or disabilities. Instead, each child's progress can be influenced by many factors, such as experience. As Ramey and Ramey (1998) noted, "…a widespread hope for early intervention (is) . . . that children could be placed on a normative developmental trajectory and thus continue to show optimal development after early intervention ends" (p. 113). Accordingly, they posited a "zone of modifiability," a period of time during which the precise developmental trajectory for children at risk is likely determined by the timing, intensity, and appropriateness of treatment. Convergent evidence supporting this hypothesis has come from a variety of sources. Longitudinal studies (e.g., the North Carolina Abecedarian Project, Infant Health and Development Program) demonstrated that the effects of early intervention on children at risk for developmental delay and mental retardation were evident when the children were 3 years old, and some gains were maintained into adolescence and adulthood (Campbell, Pungello, Miller-Johnson, Burchinal, & Ramey, 2001; Campbell, Ramey, Pungello, Sparling, & Miller-Johnson, 2002; for a review, see Ramey & Ramey, 1999).The likelihood that effective early intervention can produce lasting neurobiological as well as behavioral changes has been suggested by research showing that early experiences play a critical role in shaping brain architecture as well as brain function (Dawson & Fischer, 1994; Shore, 1997). Additionally, studies have shown that specific types of interactions with the physical and social environment can remediate some types of damage to the central nervous system (e.g., Hannigan & Berman, 2000). In a series of studies using mouse models of some mental retardation syndromes and neurological disorders, Schroeder, Tessel, and their colleagues demonstrated that behavior analytic discrimination training reversed abnormalities in brain structures and neurotransmitter levels as well as learning and behavior. Training was most effective when it began early in development (Loupe, Schroeder, & Tessel,1995; Stodgell, Schroeder,& Tessel, 1996; Tessel, Schroeder, Loupe, & Stodgell, 1995; VanKeuren, Stodgell, Schroeder, & Tessel, 1998).

Findings from early intervention research indicate that treatment that is intensive, long in duration, and delivered directly to children (rather than just to their caregivers) produces better outcomes than treatment that lacks those elements (Ramey & Ramey, 1998, 1999). Few of those variables have been isolated and investigated in controlled studies, however. For example, despite the apparent relationship between the intensity of early intervention and outcome (e.g., Guralnick, 1998), there has been little experimental research on the effects of treatment intensity or duration. Nor has there been much research on the relation between type of early intervention and outcomes. Guralnick (1998) argued that the next generation of research in early intervention must progress beyond basic demonstrations of its effectiveness. There is a need for studies that delineate which aspects of early intervention are most efficacious, and for which populations. A better understanding of the optimal timing, intensity, duration, and type of intervention could benefit all children who have or are at risk for developmental delays. Given the reported recent increase in the number of children diagnosed with autism spectrum disorders, such issues may be particularly germane to this population (e.g., California Department of Developmental Services 2003a; Yeargin-Allsop et al., 2003; but see Fombonne, 2001, 2003 for critiques of such reports). In addition, the cost of lifespan services for people with autism may be disproportionately higher than the cost of serving individuals with other disabilities (e.g., California Department of Developmental Services, 2002, 2003b). Effective early intervention can substantially reduce those costs (Jacobson, Mulick, & Green, 1998). Therefore, there are several compelling reasons to examine outcomes produced by various types of early intervention for children with autism.

There is considerable empirical evidence that early intensive behavior analytic intervention produces large and lasting functional improvements in many children with autism. Although a number of behavior analysts have been documenting the effectiveness of behavior analytic intervention for individuals with autism since the early 1960s (e.g., Ferster & DeMyer, 1961; Wolf, Risley, & Mees, 1964; see also Matson, Benavidez, Compton, Paclawskyj, & Baglio, 1996), a study by Lovaas (1987) was singular for documenting substantially improved functioning in a sizeable proportion of children who received comprehensive, intensive, long-duration behavior analytic intervention starting before they reached 4 years of age. Nine of 19 children in that study who received early intensive behavior analytic treatment for at least two years had cognitive and language test scores in the normal range by the age of 6-7 years and completed first grade without special instruction. In contrast, few gains were made by children with autism in two control groups who received either 10 hours of behavior analytic treatment per week or typically available community services over the same time period. A follow-up study found that the "best outcome" children from the Lovaas (1987) study continued to function normally into adolescence (McEachin, Smith, & Lovaas, 1993).

Several studies of comprehensive, intensive behavior analytic treatment for young children with autism spectrum disorders have been published prior to and since the Lovaas (1987) study. Collectively, these studies have documented the efficacy of intensive behavior analytic intervention, both center-based (e.g., Eikeseth, Smith, Jahr, & Eldevik, 2002; Fenske, Zalenski, Krantz, & McClannahan, 1985; Harris, Handleman, Gordon, Kristoff, & Fuentes, 1991) and home-based (e.g., Anderson, Avery, DiPietro, Edwards, & Christian, 1987; Birnbrauer & Leach, 1993; Smith, Groen, & Wynne, 2000; Weiss, 1999). In several studies, standardized test data indicated that cognitive functioning, language skills, and academic performance approached or exceeded normal levels in many children who received at least two years of early intensive behavior analytic treatment (for a review, see Green, 1996 and Smith, 1999). Instruments such as the Vineland Adaptive Behavior Scales also detected substantial improvements in adaptive functioning (Anderson et al., 1987; Birnbrauer & Leach, 1993; Smith et al., 2000; Weiss, 1999). Similar outcomes have been documented in systematic case studies in which independent evaluators used objective measurement instruments to track children's progress (Green, Brennan, & Fein, 2002; Perry, Cohen, & De Carlo, 1995). Finally, parents whose children received intensive behavior analytic intervention showed high satisfaction and reduced stress over the course of treatment in comparison to parents whose children did not receive intensive behavior analytic intervention (Anderson et al., 1987; Birnbrauer & Leach, 1993; Smith et al., 2000).

Although all published studies of early intensive behavior analytic treatment demonstrated that many children made substantial gains, outcomes varied within and across studies. The proportions of intensively treated children who achieved normal or near-normal functioning, more modest improvements, and relatively small improvements varied from study to study (Green, 1996; Smith, 1999). For instance, a smaller percentage of children in the Smith et al. (2000) study were able to function independently in regular classrooms post-treatment than was reported by Lovaas (1987), and no children were reported to be enrolled in general education settings without supports in the Anderson et al. (1987) and Birnbrauer and Leach (1993) studies. Those studies differed in several important ways from the Lovaas (1987) study, however. None involved the 40 hours of intensive treatment per week that was provided to the experimental group in the Lovaas (1987) study. Additionally, participants in those studies had lower pre-treatment language and IQ scores and received intervention for a shorter period of time than their counterparts in the Lovaas (1987) study. There were also methodological differences across studies: some were quasi-experimental while others used true experimental designs, and few assigned participants to groups randomly (see Green, 1996; Kasari, 2002; Rogers, 1998; Smith, 1999). Indeed, although some partial and systematic replications of the Lovaas (1987) study have been published, so far no full replications (40 hours of treatment per week for a minimum of two years; multiple outcome measures; at least one control group) have appeared in the literature. Nevertheless, as an aggregate, the published studies offer compelling evidence that many children with autism who received early intensive behavior analytic treatment made substantial gains.

In contrast, there is little objective empirical evidence regarding the efficacy of non-behavior analytic intervention models such as Treatment and Education of Autistic and Related Communication Handicapped Children (TEACCH; e.g., Schopler, 1997) or developmental approaches, such as the Colorado Health Sciences Program (Rogers & DiLalla, 1991; Rogers, Herbison, Lewis, Pantone, & Reis, 1986). Of the total of 15 early autism intervention outcome studies evaluated in three separate reviews, only five were evaluations of what the authors characterized as non-behavior analytic treatments. Reported treatment effects consisted of small mean gains in standardized test scores (e.g., IQ, language) or changes in developmental levels on measures not widely employed to assess functioning in children; all had serious methodological limitations. Further, no studies comparing early intensive behavior analytic treatment directly with TEACCH, Colorado Health Sciences, or any other comprehensive treatment model have been published to date (Kasari, 2002; Rogers, 1998; Smith, 1999). Several studies, however, have compared outcomes of intensive behavior analytic treatment with those resulting from standard interventions that are typically provided to children with autism through public early intervention and special education programs. In the Lovaas (1987) study, the 41 participants in control groups 1 and 2 were described as receiving treatments consisting of "resources in the community such as those provided by small education classes." Control group 1 also received behavior analytic treatment for 10 hours per week. Few gains were documented for children in those groups over the course of two or more years of treatment. Similarly, a comparison group of children in the study by Smith et al. (2000) who were enrolled in public schools for 10 to 15 hours per week made little improvement.

Recently Eikeseth and colleagues (2002) compared the effects of intensive behavior analytic treatment with equally intensive and relatively well-specified “eclectic” treatment that is similar to the type of intervention that many children with autism receive in public schools and some private programs. These investigators studied the effects of intervention provided for 30 hours per week for one year on children with autism who were 4-7 years of age when they entered treatment. Eleven children received behavior analytic intervention, while 11 other children received intensive treatment using a combination of methods including discrete trial training, TEACCH-based procedures, and sensory integration therapy. All children received 1:1 treatment from therapists who all had similar educational backgrounds and training. Each therapist received weekly consultation from behavior analysts. Additional training was provided to parents and therapists of children in the intensive behavior analytic treatment group. After one year the children in the behavior analytic treatment group performed significantly better on standardized measures of cognitive, language, and adaptive functioning than the children in the intensive “eclectic” treatment group. For example, children in the behavior analytic treatment group gained an average of 17 points on standardized measures of cognitive functioning. At followup, seven children in the behavior analytic treatment group achieved scores in the normal range of functioning, while only two children in the “eclectic” treatment group produced scores in the normal range. These results suggested that the type, rather than the intensity, of treatment accounted for the outcomes produced by intensive behavior analytic treatment.

“Eclectic” intervention like that provided to children in the comparison group in the Eikeseth et al. (2002) study is widely available to children with autism enrolled in public early intervention and special education programs. Yet little evidence about the efficacy of that approach has appeared in the research literature to date. The study described here was a prospective analysis of the effects of three different early intervention approaches on young children with autism spectrum disorders. Interim (14-month) outcomes for children who participated in an intensive behavior analytic treatment program were compared with those of children who received intensive “eclectic” intervention in classrooms designed exclusively for children with autism and children in non-intensive, generic early intervention programs.

Method

Participants

Referral and selection. The participants were 61 children diagnosed with autistic disorder or pervasive developmental disorder - not otherwise specified (PDD-NOS). Potential participants were referred by non-profit agencies (“regional centers”) under contract with the State of California Department of Developmental Services to provide case management for individuals with developmental disabilities. Referred children were screened for the following eligibility criteria: (a) diagnosis of autistic disorder or PDD-NOS according to DSM-IV criteria by qualified independent examiners before the child was 48 months of age; (b) entry into an intervention program before 48 months of age; (c) English as the primary language spoken in the child’s home; (d) no significant medical condition other than autistic disorder or PDD-NOS; and (e) no prior treatment of more than 100 hours.

Under an existing collaborative funding agreement between public schools and regional centers in the region where the study was conducted, individual education plan (IEP) and individual family service plan (IFSP) teams for young children with autism spectrum disorders routinely consider a range of educational options. These include but are not limited to: early intensive behavior analytic treatment (IBT) from non-public agencies; autism educational programming (AP) delivered in special education classrooms designed specifically for children with autism spectrum disorders; and generic educational programming (GP) for children with various diagnoses. Auxiliary services, such as occupational therapy and speech and language therapy, can also be considered and recommended by the IEP or IFSP teams. Although educational placement decisions regarding participants in this study were made by IEP or IFSP teams, parental preferences weighed heavily.

Eligibility criteria were met by 37 children who received IBT intervention from a nonpublic agency and 41 children who were enrolled in AP or GP programs operated by local school districts and counties from 1996 through 2003. Four children who began in the IBT group were excluded from analysis because they did not complete 7 months of intervention. Two of those children were just 2 years old when intervention began. They acquired some nonverbal skills, but their receptive and expressive language skills did not improve, and behavioral difficulties increased when the full number of intervention hours was attempted. This led their IFSP teams to recommend transition to less intensive school programs.The third child left the IBT group because the child's parents were not able to accommodate an intensive intervention program at home, and the fourth child moved out of the state. Four children who were placed in either AP or GP were excluded because their parents could not be contacted to arrange followup testing despite repeated attempts (3 children), or because the parent did not allow the child to be tested at followup (1 child). Nine other children (4 in the IBT group and 5 in the AP and GP groups) were excluded because more than 18 months elapsed between intake and opportunity for followup. Because the followup testing did not occur, it was not possible to confirm the treatment group placement (AP or GP) for those 5 participants. Remaining for analysis were intake and followup data for 29 children who received IBT, 16 children in AP, and 16 children in GP.

Characteristics. Table 1 summarizes the gender, ethnicity, diagnosis, and parents' marital status of the participants. The three groups of children were very similar on all of those characteristics at intake. Although the percentage of children with a given characteristic varied somewhat from one group to another, none of the differences between group means was statistically significant.

Table 2 summarizes the mean severity of autism (determined by the number of DSM-IV criteria for autistic disorder met) and chronological age of the participants in each group, and the mean educational levels of the participants' parents. Children in the IBT group were diagnosed at a younger age than children in the autism program, who in turn were diagnosed at a younger age than children in the generic program. Children in the IBT group also began treatment earlier, and had earlier followup testing, than children in the AP and GP groups. Parents of children in the IBT group averaged 1-2 more years of education than parents of children in the other two groups. All of those differences were statistically significant, and were controlled for in subsequent analyses.

Interventions

Participants' files, including IFSP or IEP documents for the year following diagnosis, were reviewed to determine services received, educational placement, and number of hours of intervention per week for each child in the AP and GP groups. For those groups, classroom and intervention descriptions were obtained through direct observation of the programs, interviews with classroom and administrative staff of those programs, and interviews with regional center staff familiar with the programs. The first two authors, who directed the IBT program, provided information about that intervention.

Intensive behavior analytic treatment (IBT). Children in the IBT group received intervention in multiple settings including home, school, and the community. Intensive treatment was defined as 25-30 hours per week of 1:1 intervention for children under 3 years of age and 35-40 hours of 1:1 intervention for children over 3 years of age. Children had 50-100 learning opportunities per hour presented via discrete trial, incidental teaching, and other behavior analytic procedures (see Anderson & Romanczyk, 1999; Green, 1996; Hall, 1997). Instruction occurred during formal, structured sessions as well as less structured situations, such as supervised play dates with typically developing peers.

Each child's program comprised individualized goals and objectives derived from ongoing evaluations employing both standardized tests and direct observational measurement. Programs similar to those described in several treatment manuals (e.g., Maurice, Green, & Luce, 1996; Maurice, Green, & Foxx, 2001) were delivered using a combination of behavior analytic techniques, including general case programming to maximize skill generalization and most-to-least prompt and prompt-fading procedures to minimize errors during skill acquisition. Children were taught to select their own reinforcers, record their own performances, and sequence their learning activities as appropriate for each child. Direct observational data on each child's progress were reviewed by program supervisors several times each week, and intervention procedures (e.g., reinforcers, instructions, prompts, pacing of learning opportunities, etc.) were modified as needed.

Each child's programming was delivered by a team of 4-5 instructional assistants, each of whom worked 6-9 hours per week with the child. Instructional assistants were employed part-time while they attended college. They were trained and supervised by staff with master's degrees in psychology or special education and coursework as well as supervised practical experience in applied behavior analysis with children with autism. Some supervisors were assisted by staff with Bachelor-level degrees and (typically) graduate coursework in behavior analysis. Each supervisor was responsible for programming for 5-9 children and worked under the direction of a Board Certified Behavior Analyst who was also a licensed psychologist (the first author) and a licensed speech and language pathologist (the second author). Parents received training in basic behavior analytic strategies, assisted in the collection of maintenance and generalization data, implemented programs with their children outside of regularly scheduled intervention hours, and met with agency staff 1-2 times a month. No additional services, such as occupational therapy or individual or small group speech therapy, were provided to the children in the IBT group. Although efforts were made to ensure treatment integrity (e.g., through frequent direct observation and videotaping of staff implementing procedures with children, and frequent feedback from supervisors), no formal measurement of treatment integrity was undertaken.

Autism educational programming (AP). Children in the AP comparison group were enrolled in public school classrooms designed for children with autism. The staff:child ratio was 1:1 or 1:2, depending on individual needs and the structure of the particular program in which each child was enrolled. A credentialed special education teacher supervised the work of 4-8 paraprofessional aides in each classroom. Staff provided 25-30 hours of intervention each week, utilizing a variety of methods designed primarily for children with autism spectrum disorders. They included discrete trial training, Picture Exchange Communication System (PECS; Bondy & Frost, 1994), sensory integration therapy, and activities drawn from the TEACCH model. In addition, other activities common to preschool programs for typically developing children (e.g., "circle time" and music activities) were incorporated into daily routines. Classroom teachers received consultation from staff with 1-2 years of graduate-level coursework in behavior analysis but who had not yet completed masters' degrees. Seven of the 16 children in the autism programs also received individual or small group speech therapy sessions 1-2 times weekly from a certified speech and language pathologist. No measures of the integrity of this treatment were available.

Generic educational programming (GP). Children in the GP comparison group were enrolled in local community special education classrooms identified as early intervention or communicatively handicapped preschool programs. Those programs served children with a variety of disabilities, and provided an average of 15 hours of intervention per week, with a 1:6 adult: child ratio. Each classroom was staffed by credentialed special education teachers or certified speech and language pathologists who supervised 1-2 paraprofessional aides. Educational activities were described as "developmentally appropriate," with an emphasis on exposure to language, play activities, and a variety of sensory experiences. Thirteen of the 16 children in this group also received individual or small group speech and language therapy sessions 1-2 times weekly from a certified speech and language pathologist. No operational definitions of this intervention were available, nor were measures of treatment integrity.

Dependent Measures

Assessments were conducted by experienced psychologists and speech and language pathologists who were independent contractors with the local regional center and who were not involved in delivering treatment to any of the children in the study. A test battery, developed by regional center staff to measure intellectual, nonverbal problem solving, language, and adaptive skills was administered annually to all children with autism spectrum disorders below 6 years of age in the region. Assessments were conducted in the child's home, in a clinician's office, or at the regional center as agreed to by the assessors and the parents. Intake testing of participants in this study was conducted within 2 months of treatment entry. Followup testing occurred an average of 14 months after treatment entry. The previously described educational placement data were gathered concurrently with followup testing. Some children did not complete the entire test battery at intake or followup. Table 3 summarizes the numbers of children in each group for whom scores were available at intake and followup for each dependent measure.

Cognitive skills. The standard administration of the Bayley Scales of Infant Development-Revised (BSID-R; Bayley, 1993) provided intake measures of intellectual functioning for 42 participants. The BSID-R is widely used with both typical children and children with autism in the age group encompassed by this study (standard scores are available for ages 2-42 months). The BSID-R yields a mental development index (MDI), which was used as the standard score for intellectual functioning in our analyses. Other tests of cognitive skills administered at intake were the Wechsler Primary Preschool Scales of Intelligence-Revised (WPPSI-R; Wechsler, 1989; 10 children), Developmental Profile-II (DP-II; Alpern, Boll, & Shearer, 1986; 3 children), and the Stanford-Binet Intelligence Scale, Fourth Edition (S-B; Thorndike, Hagen, & Sattler, 1986; 2 children). In addition, the Differential Abilities Scale (DAS; Elliott, 1990), Developmental Assessment of Young Children (DAYC; Voress & Maddox, 1998) and the Psychoeducational Profile Revised (PEP-R; Schopler, Reichler, Bashford, Lansing, & Marcus, 1990) were administered to one child each. One child did not receive a test of intellectual functioning at intake.

The test used at followup varied with the chronological age of the child. Most children received the WPPSI-R (47 children). For those children the full-scale IQ score represented the standard score for cognitive functioning in our analyses. Other tests administered at followup were the BSID-II (4 children), Stanford-Binet (3 children), and the DAS (2 children). Three children did not receive tests of intellectual functioning at followup, and 2 others (1 in the AP group and 1 in the IBT group) were deemed “untestable” by the evaluators when the WPPSI-R was attempted.

Nonverbal skills. The Merrill-Palmer Scale of Mental Tests (Stutsman, 1948) was administered to 48 children at intake and 54 children at followup. It assesses visual-spatial skills and has norms available for ages 18-78 months. The instrument is widely used due to its appealing materials, “hands-on” nature, and minimal attention demand characteristics. There is also evidence that it has predictive validity with nonverbal young children (Lord & Schopler, 1989). Test scores are expressed as standard scores and age equivalents. Nonverbal skills for one child were assessed by the Stanford-Binet Performance Test. One child received the Leiter International Performance Scale Revised (Leiter-R; Roid & Miller, 1997) at followup.

Receptive and expressive language. The Reynell Developmental Language Scales (Reynell & Gruber, 1990) were used to assess receptive and expressive language development for 46 children at intake and 47 children at followup. This instrument expresses scores in developmental ages, standard scores, and percentiles relative to a normative group. It is also widely used to test young children with autism due to its colorful materials, reliance on motor responses, and minimal attention demand characteristics. Other tests of language functioning administered at intake were the Rossetti Infant-Toddler Language Scale (Rossetti, 1990; 5 children), the Receptive - Expressive Emergent Language Scales-Revised (REEL-2; Bzoch & League, 1991; 3 children) and the Preschool Language Scale-3 (PLS-3; Zimmerman, Steiner, & Pond, 1992; 3 children). The Infant -Toddler Developmental Assessment (Provence, Eriksen, Vater, & Palmeri, 1985), the Peabody Picture Vocabulary Test –3rd edition (PPVT-III; Dunn & Dunn, 1997) in conjunction with the Expressive Vocabulary Test (EVT; Williams, 1997), and the language scale of the DP-II were also used to assess language development at intake (1 child each). Other tests administered at followup were the Sequenced Inventory of Communication Development-Revised Edition (SICD-R;

Hedrick, Prather, & Tobin, 1984; 3 children), the PLS, and the PPVT-III in conjunction with the EVT (2 children each). One child was assessed at followup with both the Expressive One-Word PictureVocabulary Test (EOWPVT; Brownell, 2000a) and the Receptive One-Word PictureVocabulary Test (ROWPVT; Brownell, 2000b). One child did not receive a language functioning test at intake, and 6 children did not receive followup language tests.

Adaptive skills. The Vineland Adaptive Behavior Scales: Interview Edition (VABS; Sparrow, Balla & Cicchetti, 1984) was administered both at intake (54 children) and followup (56 children) to the parents or primary caregivers of all participants in the study. The VABS is the most widely used assessment of adaptive skills and is viewed as a valid measure of overall adjustment in children with autism spectrum disorders (Klin, Carter, & Sparrow, 1997; Newsom & Hovanitz, 1997). The VABS yields a composite score expressed as a standard score and four domain scores (communication, daily living, socialization, and motor skills), expressed either as standard scores or age equivalents. All were used in our analyses. Other intake tests of adaptive skills were the personal adjustment or self-help subscales of the Denver Developmental Screening Test II (Frankenburg, Dodds, Archer, Shapiro, & Bresnick, 1992; 3 children), the DP-II (Alpern et al., 1986; 1 child), and the Rockford Infant Development Evaluation Scales (RIDES; Project RHISE, 1979; 1 child each). Two children did not receive tests of adaptive skills at intake, and 6 children did not receive followup tests of adaptive skills.

Data Analyses

In our statistical analyses we were primarily interested in comparing the test scores of children in the IBT group with those of children in the AP and GP groups, to determine the efficacy of IBT relative to the other forms of treatment. A secondary comparison of interest (statistically orthogonal to the comparison of primary interest) was between the test scores of children in the AP group and those of children in the GP group, to determine if the effects of those two forms of treatment differed from each other. Several statistical approaches are available to make these comparisons, including t-tests and planned contrasts. We sought to avoid approaches (such as t-tests) that evaluate data at the group level, because they cannot readily accommodate individual differences. This was a concern in our study, because the average age at diagnosis differed between the three groups of children, and because parents of children in the IBT group were more educated, on average, than parents of the children in the other two groups. Accordingly, we used multiple regression to compare the three groups of children while controlling for individual differences in age at diagnosis and parental education.

For the multiple regression analyses, we created a variable that was used to compare the children in the IBT group with the children in the AP and GP groups by assigning a numeric code of 1 to children in the IBT group and a numeric code of –1 to children in the other groups. Similarly, we created a variable that was used to compare the children in the AP group with the children in the GP group by assigning a numeric code of 0 to children in the IBT group, a numeric code of –1 to children in the AP group, and a numeric code of 1 to children in the GP group. All analyses included both of these variables. All analyses also included age at diagnosis and parents' mean level of education, to control for the potential influence of those two variables. The parents' mean level of education was used instead of entering maternal and paternal education levels as separate variables, because the maternal and paternal years of education were highly correlated (r = .52).

The children in the IBT group were younger, on average, than the children in the other two groups at both intake and followup testing. No specific correction was made for age at testing, however. Such a correction could only have affected analyses of age equivalents; standard scores and learning rates already correct for age at testing. Furthermore, by controlling for age at diagnosis we essentially controlled for age at testing as well, because age at diagnosis was highly correlated with age at intake testing ($r = .78$) and age at follow-up testing ($r = .79$).

Learning rates prior to intake were calculated for nonverbal, receptive language, expressive language, communication, daily living, social, and motor skills by dividing the age equivalent at intake by the child's chronological age in months.Nonverbal learning rates were based on the age equivalent scores derived from the Merrill-Palmer. Receptive and expressive language learning rates were calculated using age equivalents from standardized language assessments. Communication, daily living, social, and motor learning rates were derived from age equivalent scores on the VABS. Learning rates during the intervention period were calculated by subtracting the intake age equivalent score on the measure in question from the age equivalent score at followup, and then dividing by the interval between intake and followup testing.

Results

Intake

At intake there was clear evidence of developmental delay in all three groups of children. For most skill domains, the mean standard scores for all three groups were substantially below 100, and the mean learning rates were well below the normal rate of one year of development per year of age (see Table 4). As might be expected, delays were most prominent in receptive and expressive language skills, with mean standard scores in all three groups close to 50, and mean learning rates of about 0.5 age equivalents per year (i.e., half the normal learning rate).

The mean scores of all three groups of children on all measures were similar at intake. The only difference that reached statistical significance was in the nonverbal skills domain, where the GP group had a significantly higher mean age equivalent score than the AP group.

Followup

At followup, there were no statistically significant differences between the mean scores of children in the AP and GP groups (see Table 5). In contrast, the IBT group had higher mean scores in all domains than the other two groups combined. Those differences were statistically significant. The only exception to this general finding was in the motor skills domain, which yielded no statistically significant group differences when results were expressed as learning rates. The IBT group had mean standard scores in the normal range on cognitive, nonverbal, communication, and motor skills, whereas the only mean score in the normal range for the AP and GP groups was in motor skills (which were not substantially delayed at intake). Differential treatment effects were also reflected in changes exhibited by individual children within the three groups. For example, the cognitive (IQ) scores of 13 children in the IBT group increased from one standard deviation or more below average (i.e., IQ of 85 or lower) at intake to within one standard deviation of average or above (i.e., IQ of 86 or higher) at followup. Three children in that group had IQ scores in or near the normal range at intake (84, 89, and 97); at followup their IQ scores had increased to 122, 114, and 102, respectively. In the AP group, no children had IQ scores in the normal range at intake; at followup, the IQ scores of two children had moved into the normal range. Three children in the GP group had IQ scores that moved from one or more standard deviations below average at intake to within the normal range at followup; however, the two children in that group whose IQ scores were in the normal range at intake actually had lower IQ scores at followup (from 91 to 77 and 89 to 85).

Table 5 also shows that IBT produced normal or above-normal mean learning rates in all skill domains, although the learning rate for motor skills was near normal for this group as well as the other two groups of children before intervention. In contrast, only nonverbal skills were acquired at close to normal rates by children in the other two treatment groups during the intervention period (means = 0.87 and 0.90, respectively). Differential treatment effects were most evident when rates of acquisition of language skills were compared. Inspection of Figures 1 and 2 reveals that those differences were not restricted to just a few children. Prior to intake, children in all three groups exhibited similar, below-normal rates of learning receptive language skills, although two children in the IBT group were acquiring receptive language skills at a normal rate prior to intervention (Figure 1). At followup, all but 8 children in the IBT group were acquiring receptive language skills at a normal rate, with several achieving at above-normal rates and two others at near-normal rates. In contrast, learning rates at followup remained below normal for the large majority of children in the AP and GP groups. A small number of children in all three groups, however, appeared to have lower learning rates in this domain at followup than at intake.

Figure 2 shows similar patterns for expressive language skills, At intake, all children in the IBT group had expressive language learning rates that were below normal; at followup, all but 9 of those children were acquiring those skills at normal rates, with rates accelerated to substantially above normal for several children. Two additional children in this group had near-normal learning rates at followup. All children in the AP and GP groups also had below-normal rates of acquisition of expressive language skills at intake. At followup, although 1-2 children in each group exhibited normal or above-normal learning rates, the rate of acquisition of expressive language skills actually *declined* over the course of intervention for several children in both groups. Some of the factors that contributed to these between-group and individual differences will be explored in a subsequent paper.

Since the mean scores for all three groups of children on all dependent measures were similar at intake, the analysis of change scores yielded results that were similar to those that emerged from analyzing the followup scores (see Table 6). Some interesting additional information was revealed by this analysis. Children in the IBT group exhibited statistically significantly larger mean treatment gains in all domains than children in the AP and GP groups combined, with the possible exception of the motor skills domain (which was significant only when standard scores were used). Indeed, the IBT group had mean gains in standard scores in all skill domains, ranging from 1.38 points in motor skills (which were already near-normal at intake) to 29.72 points in cognitive skills. The AP group's change scores ranged from –5.13 points in the motor skills domain to 8.44 points in cognitive skills. Mean change scores for this group actually revealed *losses* in social and motor skills as well as the VABS composite score, and negligible-to-small gains in the other domains. For the GP group, mean change scores ranged from –7.43 in daily living skills to 8.94 in cognitive skills, with losses in receptive language, expressive language, daily living, social, and motor skills as well as the VABS composite score. Similar patterns emerged when age equivalents were used in change score analyses: the IBT group made gains in all domains (range = 13.44 – 20.81 months), gaining more than 14 months developmentally, on average, in nonverbal, receptive language, expressive language, overall communication, social, and motor skills over the 14-month intake-to-followup period. Mean age equivalent gains for the AP and GP groups were much smaller and were less than 14 months in all domains (ranges = 7.53 – 12.63 months and 4.5 – 13.17 months, respectively).

Discussion

Young children with autism or PDD-NOS who received intensive behavior analytic treatment (IBT) for about 14 months outperformed comparable children who received "eclectic" intervention services for the same period of time on virtually every followup measure. In most cases the differences in mean scores were substantial and statistically significant. Our analyses corrected for the parents' level of education and for the children's ages at diagnosis. No direct correction was made for the age at testing, but children in the IBT group had the highest mean age equivalents at followup (see Table 5), despite being younger than the children in the other groups. Thus, our findings cannot be attributed to differences in age at testing; if anything, they underestimate the effect of IBT on age equivalents. These results are consistent with those reported by other investigators who found that providing at least 30 hours of competently delivered, intensive behavior analytic intervention to preschool-age children with autism produced large improvements in intellectual functioning, communication skills, and adaptive behavior. We reported gains measured just 14 months into treatment, so it was not surprising that they were generally smaller than gains that have been documented after 2-3 years of IBT (e.g., Green et al., 2002; Lovaas, 1987; Perry et al., 1995; Weiss, 1999). The gains we observed, however, were generally larger than gains reported by Anderson et al. (1987) for preschool children with autism who received only 15-25 hours of behavior analytic treatment for one year.

Analyses of learning rates (Table 5, Figures 1 and 2) provided further evidence of the efficacy of IBT for accelerating rates of skill acquisition. During 14 months of treatment, children in the IBT group acquired skills in most domains at a rate that matched or exceeded the normal rate of one year of development per year of age. That was not the case for the children in the AP and GP groups; with very few exceptions, their learning rates remained well below normal. If children with autism are to have any chance to close the gap between their skills and those of their typically developing peers, their developmental trajectories must be increased sharply while they are young, before the gap widens even further. That is, their learning rates need to *exceed* the normal rate for an extended period of time. Of the early intervention approaches investigated in this study, only IBT had that effect, producing above-normal mean learning rates in the nonverbal, receptive language, expressive language, overall communication, and social skill domains. It is important to note, however, that 14 months of accelerated development was not enough for the children in the IBT group to make up all of the differences between their skills and those of typically developing preschoolers. Previous research suggests that at least 1-2 additional years of IBT will be required before some of those children will have the repertoires required to learn effectively in typical classrooms without ongoing specialized intervention; some will require more than that, and some will likely not reach that point even with additional IBT (see Green, 1996;

Smith, 1999). Projections based on the developmental trajectories produced by IBT in our study suggest that most children will continue to make progress toward catching up with their typically developing peers if they continue receiving competently delivered IBT.

Our findings also shed some empirical light on the relation between the type and intensity of early intervention and benefits for children with autism. "Eclectic" treatment (a combination of TEACCH, sensory integration therapy, and some applied behavior analysis methods) did not prove very effective for our AP comparison group, even though it was provided intensively (i.e., for 30 hours per week with adult:child ratios of 1:1 or 1:2) in classrooms specifically designed for children with autism by staff with considerable training and experience with the population. Mean change scores in all skill domains were substantially lower for the AP group than for their counterparts who received IBT, in fact reflecting losses rather than gains in some areas over 14 months of treatment (Table 6). These findings are consistent with those reported by Eikeseth et al. (2002) for a group of children with autism aged 4-7 years who received similarly intensive "eclectic" treatment in special education classrooms for one year. Thus the popular notion that virtually *any* intervention can produce meaningful benefits for children with autism if it is provided intensively has not been confirmed by two controlled studies that addressed that hypothesis. Instead, IBT produced substantially larger improvements than intensive "eclectic" treatment in both studies. The nonintensive "eclectic" treatment experienced by our GP group (15 hours per week of "developmentally appropriate" activities and sensory experiences provided in a 1:6 adult:child ratio) was not just ineffective; it produced *negative* mean change scores in multiple skill domains. In short, the effect of "eclectic" treatment on both the AP and GP groups was to flatten or decrease rather than increase the slopes of the developmental trajectories of most children. Based on these findings, we would project that those children will lose more ground to their typically developing peers the longer they remain in such intervention programs.

The ineffectiveness of the "eclectic" early intervention provided to children in the AP and GP groups in this study should not be surprising. "Eclectic" intervention necessarily involves multiple transitions per day from one activity or "therapy" to another, and a good deal of variability in the way intervention is provided by the various adults involved. Children with autism often do not respond well to changes in routines, have substantial attentional difficulties, and learn best when instruction is consistent. It does not stand to reason that typical "eclectic" programming provided in a group format is likely to produce meaningful benefits for children with those characteristics. Nor does it follow logically that combining several "therapies" or methods for which there is limited scientific evidence of effectiveness (such as TEACCH, developmental models, and sensory integration therapy; see Arendt, MacLean, & Baumeister, 1988; Dawson & Watling, 2000; Smith, 1999) is likely to be beneficial for young children with autism. What is surprising is how few scientific studies heretofore have evaluated the "eclectic" approach, and how many prominent individuals and organizations in the autism community and the education establishment endorse and promote it.

One interesting observation that was common to all three treatment groups in this study was a change in the distributions of language learning rates from pre-treatment to followup (see Figures 1 and 2). For all three groups, the spreads of the distributions were considerably greater at followup than before treatment, and some modes shifted as well. Those changes may have been due in part to sampling errors, which could have been magnified in the followup data because the followup learning rates were based on a shorter time period than were the pre-treatment learning rates (14 months versus 34 months, on average). It is likely that sampling errors affected all data sets equally, however, so the relative between-group differences in learning rate distributions likely reflect differential treatment effectiveness. Here again, the effects of IBT appeared to differ substantially from the effects of the other two interventions. Figure 1 shows that for the IBT group, the mode of the distribution of learning rates for receptive language skills moved from well below normal before treatment to above normal after 14 months of treatment, with many more children achieving normal rates at followup than prior to intervention. The mode of the distribution of receptive language learning rates for the intensive "eclectic" intervention (AP) group was slightly higher but still well below normal at followup, with three children acquiring receptive language skills at normal rates after 14 months. For the GP group, the mode of the distribution of receptive language learning rates was lower at followup than pre-treatment, although two children in that group were acquiring receptive language skills at normal rates at followup. With regard to rates of acquiring expressive language skills (Figure 2), the distribution spread markedly with IBT, with a number of children in that group exhibiting learning rates that were well above normal at followup. Prior to intervention, the modal learning rate for the IBT group was well below normal; at followup a bimodal distribution was observed, with one mode substantially above normal and the other just below normal. Intensive "eclectic" treatment also appeared to produce greater spread in the distribution of expressive language learning rates for the AP group, but only a slight upward shift in the mode. The nonintensive "eclectic" intervention (GP) group showed a slightly increased spread in the distribution of learning rates for expressive communication skills at followup, but the mode shifted down rather than up.

Several limitations to this study constrain the interpretation of our results. First, assignment to treatment groups was parent-determined rather than random; however, the three groups were very similar on key dependent measures before treatment began, which is the main purpose of random assignment (cf. Baer, 1993; Kasari, 2002). Thus, differences in outcomes across the three groups were likely due to the treatments rather than to any selection bias or pre-treatment differences among the groups. Second, the examiners who conducted the assessments were not blind as to the children's group assignments at followup testing. They were, however, independent of the investigators as well as all three intervention programs. It could be argued that some of the examiners were biased toward IBT, which led them to overestimate the followup status of children in that group. Since there were a large number of examiners, however, it is just as likely that some of them were biased *against* IBT and *toward* the other interventions. Third, results were analyzed only in terms of performances on standardized, norm-referenced assessments conducted in formal testing situations, rather than the repeated direct observational measurement of behavior *in situ* that characterizes applied behavior analysis. Additionally, the analyses compared group mean scores statistically. Group mean scores may not accurately represent the actual performance of any individual in the group, and between-groups statistical comparisons of mean scores cannot reveal clinically significant changes in individual behavior over time (Johnston & Pennypacker, 1993). Nonetheless, standardized instruments like IQ tests and adaptive behavior scales are widely used in autism research, and scores on such tests have been shown to correlate reasonably well with overall adjustment for individuals with autism (e.g., Klin et al, 1997). Further, between-groups comparisons are helpful for answering actuarial questions, such as the relative efficacy of interventions for groups of children with autism. Finally, treatment integrity was not measured in this study. The behavior analytic treatment was directed by individuals with documented training and credentials in applied behavior analysis, and incorporated techniques that have been operationally defined and tested in many previous studies (see Green, 1996, 2001; Matson et al., 1996). Staff in that program were trained and supervised closely, but it cannot be assumed that they implemented treatment procedures with fidelity and consistency throughout the study. Even fewer assumptions can be made about the other interventions. Indeed, measuring the integrity of those interventions would likely prove challenging, because many of the techniques employed have not been operationally defined or evaluated, and the skills required to implement them have not been well-specified.

As noted previously, we plan to conduct further analyses of child, family, and treatment variables that were correlated with the differential outcomes reported here. Additional research on the importance of such variables is needed to inform decision-making by families and policymakers, and to aid in the development of new or modified interventions for children with autism spectrum disorders who do not respond to IBT. Studies that further investigate the short- and long-term effects of "eclectic" intervention are also needed, given the widespread popularity and availability of that approach for children with autism spectrum disorders. The same can be said of early intervention that is based primarily or exclusively on models that have not yet been subjected to thorough scientific evaluations, such as TEACCH, "developmentally appropriate" programming, "floor time," Relationship Development Intervention, and sensorimotor techniques.

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Table 1
Number of Participants with Each Characteristic

	Treatment group		
Characteristic	IBT	AP	GP
Gender			
Male	25 (86%)	13 (81%)	16 (100%)
Female	4 (14%)	3 (19%)	0 (0%)
Ethnicity			
Both parents Caucasian	21 (72%)	6 (50%)	8 (57%)
One or both parents Hispanic	4 (14%)	3 (25%)	4 (29%)
Other	4 (14%)	3 (25%)	2 (14%)
Unknown	0	4	2
Diagnosis			
Autism	24 (83%)	12 (75%)	9 (56%)
PDD-NOS	5 (17%)	4 (25%)	7 (44%)
Parents' marital status			
Married	23 (79%)	12 (80%)	9 (56%)
Not married, divorced, or separated	6 (21%)	3 (20%)	7 (44%)
Unknown	0	1	0

Note. Percentages are within each treatment group, excluding participants with unknown characteristics.

Table 2

Mean Severity of Autism, Age (in Months), and Parents' Education Level

	IBT		AP		GP		IBT mean minus	AP mean minus
Measure	*M*	*SD*	*M*	*SD*	*M*	*SD*	AP/GP mean	GP mean
Severity (no. of DSM-IV criteria)	7.55	1.39	7.27	1.56	7.33	2.02	0.25	-0.06
Age at diagnosis	30.48	5.96	39.31	5.52	34.94	5.18	-6.65**	4.37*
Age at intake	30.86	5.16	37.44	5.68	34.56	6.53	-5.16**	2.84
Age at followup	45.66	6.24	50.69	5.64	49.25	6.81	-4.31*	1.44
Months between intake and followup	14.21	2.24	13.25	2.84	14.75	1.88	0.21	1.50
Mother's years of education	14.10	2.34	13.00	1.83	13.00	1.41	1.10*	0.00
Father's years of education	14.62	2.77	13.13	2.56	13.00	1.81	1.56*	0.13
Parents' mean years of education	14.36	2.22	13.06	1.82	12.97	1.36	1.35**	0.09

Note. For the IBT group $n = 29$, except for severity ($n = 20$). For the AP group $n = 16$, except for severity ($n = 11$) and father's years of education ($n = 15$). For the GP group $n = 16$, except for severity ($n = 12$) and father's years of education ($n = 15$).

* Difference between means is statistically significant ($p < .05$).

** Difference between means is statistically significant ($p < .01$).

Table 3
Number of Children for Whom Dependent Measures were Available at Intake and Followup

	Intake / Followup		
Measure	IBT	AP	GP
Standard scores			
Cognitive	28 / 26	16 / 16	16 / 16
Nonverbal	21 / 24	16 / 16	13 / 15
Receptive	25 / 26	16 / 15	13 / 14
Expressive	25 / 26	16 / 15	13 / 14
Communication	28 / 25	16 / 16	15 / 16
Self-help	28 / 25	16 / 16	14 / 16
Social	28 / 25	16 / 16	14 / 16
Motor	28 / 25	16 / 16	13 / 16
Composite	26 / 25	16 / 16	13 / 16
Age equivalents			
Cognitive	25 / 0	11 / 0	10 / 0
Nonverbal	21 / 24	16 / 16	12 / 15
Receptive	29 / 26	16 / 15	15 / 13
Expressive	29 / 26	16 / 15	15 / 13
Communication	29 / 25	16 / 16	15 / 16
Self-help	29 / 25	16 / 16	15 / 16
Social	28 / 25	16 / 16	15 / 16
Motor	28 / 25	16 / 16	14 / 16
Learning rate			
Nonverbal	21 / 21	16 / 16	12 / 12
Receptive	29 / 26	16 / 15	15 / 12
Expressive	29 / 26	16 / 15	15 / 12
Communication	29 / 25	16 / 16	15 / 15
Self-help	29 / 25	16 / 16	15 / 15
Social	28 / 24	16 / 16	15 / 15
Motor	28 / 24	16 / 16	14 / 14

Table 4

Test Scores and Learning Rates at Intake

	IBT		AP		GP		IBT mean minus	AP mean minus
Measure	*M*	*SD*	*M*	*SD*	*M*	*SD*	AP/GP mean	GP mean
Standard scores								
Cognitive	58.54	18.15	53.69	13.50	59.88	14.85	1.76	-6.19
Nonverbal	80.14	11.86	67.44	16.69	77.69	12.33	8.11	-10.25
Receptive	52.16	18.44	45.38	14.97	49.00	13.61	5.16	-3.62
Expressive	51.88	12.91	43.88	6.69	48.77	11.61	5.81	-4.89
Communication	66.18	10.02	63.69	9.68	66.20	8.70	1.28	-2.51
Self-help	70.71	10.14	68.06	11.61	73.43	10.39	0.14	-5.37
Social	72.79	11.26	75.50	14.25	75.07	12.09	-2.51	0.43
Motor	95.11	11.70	93.19	10.10	92.08	13.84	2.42	1.11
Composite[1]	70.46	11.85	69.81	10.48	71.62	10.47	-0.16	-1.81
Age equivalents (months)								
Cognitive[1]	17.04	6.07	17.27	4.71	17.10	3.93	-0.15	0.17
Nonverbal[1]	24.43	4.37	24.75	6.01	26.83	6.95	-1.21	-2.08*
Receptive	14.57	5.82	16.81	5.36	16.60	5.34	-2.14	0.21
Expressive[1]	14.76	4.72	16.38	2.99	17.87	5.45	-2.34	-1.49
Communication[1]	14.90	4.32	16.19	6.44	16.53	5.25	-1.45	-0.34
Self-help[1]	18.24	3.83	21.44	7.78	21.20	6.67	-3.08	0.24
Social[1]	16.39	4.89	22.06	10.62	19.60	5.68	-4.48	2.46
Motor[1]	28.86	5.86	33.56	7.20	32.00	6.25	-3.97	1.56

Learning rates prior to intake (age equivalents per year)

Nonverbal	0.79	0.14	0.67	0.17	0.78	0.12	0.08	-0.11
Receptive	0.48	0.21	0.45	0.15	0.48	0.12	0.02	-0.03
Expressive	0.49	0.16	0.44	0.06	0.53	0.17	0.01	-0.09
Communication	0.49	0.15	0.43	0.15	0.49	0.15	0.04	-0.06
Self-help	0.61	0.17	0.57	0.16	0.62	0.18	0.01	-0.06
Social	0.54	0.18	0.58	0.23	0.58	0.19	-0.04	0.00
Motor	0.95	0.18	0.90	0.13	0.93	0.18	0.03	-0.04

[1]Age at diagnosis is a significant covariate ($p < .05$).

* Difference is statistically significant, after controlling for age at diagnosis and parents' level of education ($p < .05$).

Table 5
Test Scores and Learning Rates at Followup

Measure	IBT *M*	IBT *SD*	AP *M*	AP *SD*	GP *M*	GP *SD*	IBT mean minus AP/GP mean	AP mean minus GP mean
Standard scores								
Cognitive	89.88	20.87	62.13	19.63	68.81	15.32	24.42**	-6.68
Nonverbal[1]	101.67	19.14	73.56	24.94	82.53	16.76	23.77**	-8.97
Receptive	71.31	22.72	49.93	19.62	49.21	16.08	21.73*	0.72
Expressive[1]	70.46	22.88	47.67	23.39	46.79	12.81	23.21*	0.88
Communication	85.44	14.73	64.13	14.18	68.69	14.18	19.03**	-4.56
Self-help	76.56	11.59	70.00	11.92	65.19	8.84	8.97**	4.81
Social	82.08	11.73	75.00	18.01	70.56	11.77	9.30**	4.44
Motor	98.16	12.01	88.06	13.43	89.50	10.06	9.38*	-1.44
Composite	81.32	11.14	69.25	12.91	68.25	9.86	12.57**	1.00
Age equivalents (months)								
Nonverbal[2]	44.54	8.76	37.38	13.14	40.80	9.97	5.51*	-3.42
Receptive	32.23	10.04	26.27	11.56	25.38	10.00	6.37*	0.89
Expressive	31.96	12.00	24.00	12.02	23.31	7.36	8.28*	0.69
Communication	36.60	12.23	23.88	11.82	26.13	8.74	11.60**	-2.25
Self-help[2]	31.88	8.74	31.75	9.75	27.81	5.75	2.10*	3.94
Social	32.04	10.23	30.06	16.10	24.81	7.23	4.61*	5.25
Motor[2]	44.16	8.22	43.00	7.28	42.25	6.58	1.54*	0.75

Learning rates between intake and followup (age equivalents per year)								
Non-verbal	1.44	0.52	0.87	0.74	0.90	0.39	0.56**	-0.03
Receptive	1.23	0.56	0.65	0.47	0.48	0.43	0.66**	0.16
Expressive	1.22	0.73	0.49	0.78	0.33	0.45	0.80**	0.16
Communication	1.43	0.72	0.56	0.76	0.69	0.70	0.81**	-0.13
Self-help	0.91	0.58	0.74	0.80	0.48	0.49	0.30*	0.26
Social	1.04	0.74	0.60	0.94	0.40	0.67	0.54*	0.20
Motor	0.99	0.45	0.69	0.49	0.83	0.59	0.24	-0.14

[1]Parents' level of education is a significant covariate ($p < .05$).
[2]Age at diagnosis is a significant covariate ($p < .05$).
* Difference is statistically significant, after controlling for age at diagnosis and parents' level of education ($p < .05$).
** Difference is statistically significant, after controlling for age at diagnosis and parents' level of education ($p < .01$).

Table 6

Changes in Test Scores and Learning Rates

Measure	IBT *M*	IBT *SD*	AP *M*	AP *SD*	GP *M*	GP *SD*	IBT mean minus AP/GP mean	AP mean minus GP mean
Standard scores at followup minus standard scores at intake								
Cognitive	29.72	16.29	8.44	15.04	8.94	17.95	21.03**	-0.50
Non-verbal[1]	20.57	16.20	6.13	18.70	2.31	11.61	16.16**	3.82
Receptive	20.17	19.46	3.87	12.09	-4.82	14.81	19.97**	8.68
Expressive[1]	20.08	22.42	3.80	20.66	-4.45	17.25	19.78*	8.25
Communication	17.17	13.94	0.44	12.47	2.20	14.08	15.88**	-1.76
Self-help	5.92	13.60	1.94	15.29	-7.43	11.03	8.35*	9.37
Social	8.00	13.54	-0.50	14.41	-4.64	15.16	10.43*	4.14
Motor	1.38	13.90	-5.13	14.47	-1.23	19.13	4.75	-3.89
Composite	10.52	14.73	-0.56	12.04	-2.77	14.01	12.07**	2.21
Age equivalents at followup minus age equivalents at intake (in months)								
Non-verbal	20.81	7.20	12.63	11.20	13.17	5.54	7.95**	-0.54
Receptive	17.15	7.88	9.13	8.16	6.83	5.92	9.04**	2.30
Expressive	16.85	10.30	7.53	11.90	4.50	6.05	10.66**	3.03
Communication	21.00	10.88	7.69	9.73	9.53	8.87	12.42**	-1.85
Self-help	13.44	8.13	10.31	9.90	6.93	6.84	4.76*	3.38
Social	15.46	9.89	8.00	11.99	5.27	9.11	8.78**	2.73
Motor	14.33	6.20	9.44	6.83	11.43	7.85	3.97	-1.99

Learning rates between intake and followup minus learning rates prior to intake (age equivalents per year)

Non-verbal	0.65	0.53	0.20	0.73	0.12	0.38	0.49*	0.08
Receptive	0.73	0.61	0.19	0.42	-0.02	0.41	0.64**	0.21
Expressive	0.72	0.76	0.05	0.77	-0.23	0.54	0.79**	0.27
Communication	0.92	0.75	0.13	0.78	0.21	0.75	0.76**	-0.08
Self-help	0.30	0.68	0.18	0.90	-0.14	0.64	0.28*	0.32
Social	0.48	0.83	0.02	0.97	-0.18	0.78	0.56*	0.20
Motor	0.01	0.53	-0.21	0.55	-0.11	0.75	0.17	-0.10

[1]Parents' level of education is a significant covariate ($p < .05$).
* Difference is statistically significant, after controlling for age at diagnosis and parents' level of education ($p < .05$).
** Difference is statistically significant, after controlling for age at diagnosis and parents' level of education ($p < .01$).

Figure 1. Receptive language learning rates prior to intake (unfilled circles) and at followup, after about 14 months of intervention (filled circles). The dashed line indicates the normal learning rate (1 year of development for each year of age).

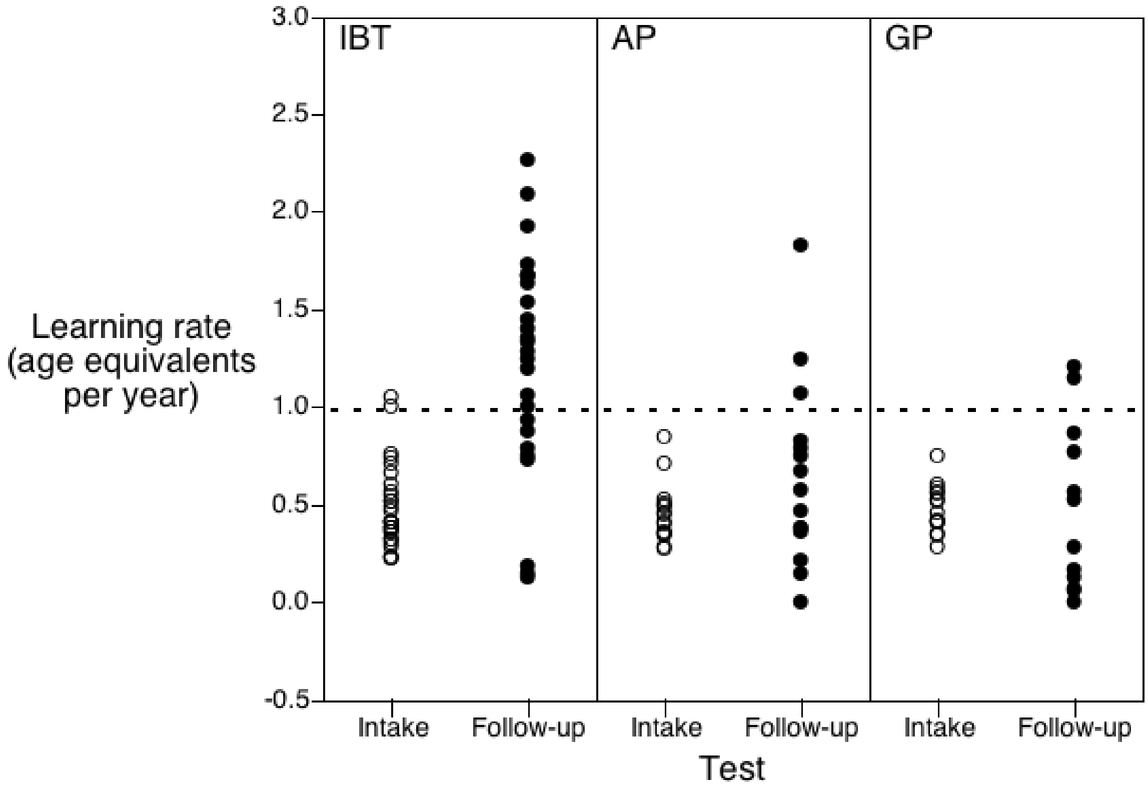

Figure 2. Expressive language learning rates prior to intake (unfilled circles) and at followup, after about 14 months of intervention (filled circles). The dashed line indicates the normal learning rate (1 year of development for each year of age).