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EIGHT CASE REPORTS OF LEARNING RECOVERY IN CHILDREN WITH PERVASIVE DEVELOPMENTAL DISORDERS AFTER EARLY INTERVENTION

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Early intensive behavioral intervention (EIBI) is often recommended for children with Pervasive Developmental Disorders (PDD). It is an empirically supported treatment designed to address the core symptoms of autism including language delays, social and play skills, and restricted and repetitive behaviors as well as other related deficits in cognition and adaptive behavior. Though there are a growing number of research studies supporting EIBI, many questions remain about the nature and stability of best outcomes. The current study provides case descriptions of eight children previously diagnosed with an autism spectrum disorder and mental retardation who, after EIBI treatment, no longer met behavioral criteria for mental retardation or a PDD. The average gain in IQ standard scores was 34.6 ($\pm$13.2) points; and, the average gain in adaptive behavior standard scores was 43 ($\pm$25.3) points. Nonverbal IQ standard scores (mean = 93 ± 12.6) and academic achievement standard scores (mean = 105.3 ± 18.7) ended within the average range. Language skills remained impaired for seven children. The cases support findings of other researchers that learning recovery in autism and PDD is possible and may be related to intensive behavioral treatment. Individual differences in response to EIBI treatment are discussed.

INTRODUCTION

Treatment for children with Pervasive Developmental Disorders (PDD), specifically autism and Pervasive Developmental Disorders, Not Otherwise Specified (PDD-NOS), has received increasing scientific and public policy attention over the last 15 years. Related to this greater awareness about autism and PDD have been descriptions of increased prevalence and professional recognition of the disorder

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(Fombonne, 2003; Smeeth et al., 2004). Despite a growing research literature, there remain serious questions about what kind of intervention works best for whom, and when costly individualized behavioral treatments are justified (Jacobson & Mulick, 2000; Mulick & Butter, 2002). In addition, parents receive inconsistent and ambiguous recommendations about appropriate intervention strategies (Johnston, Foxx, Jacobson, Green, & Mulick, 2006; National Research Council, 2001).

Early intensive behavioral intervention (EIBI) using applied behavior analysis (ABA) has received the greatest scientific scrutiny of all the intervention choices for autism and has become the gold standard treatment in the eyes of many parents and professionals (Jacobson, 2000). We were interested in EIBI because of claims of learning recovery and amelioration of intellectual disability in a substantial minority of children who receive it (Lovaas, 1987; see also Cohen, Amerine-Dickens, & Smith, 2006; Howard, Sparkman, Cohen, Green, & Stanislaw, 2005; Sallows & Graupner, 2005).

EIBI involves both prescriptions for *how* children with autism should be taught and *what* should be taught. The teaching methods of EIBI are based on principles derived from over 60 years of ABA research; including the use of reinforced practice, functional analysis, and single case experimental designs. The use of shaping procedures with precisely timed reinforcement and errorless prompting strategies are also critical to teaching and maintaining new, functional behavior in this approach. The curriculum used in EIBI programs is comprehensive and individualized to address the manifested core symptoms of autism—severe language delays, impaired social interactions, and repetitive and restricted behaviors, and can be attributed to the broad outline suggested in the earliest publications from the UCLA Young Autism Project (Lovaas, 1981; Lovaas, 1987). EIBI programs follow a systematic initial approach of teaching fundamental learning skills including generalized imitation, visual discrimination, and matching to sample to permit acquisition of language and communication skills. Subsequent learning objectives address deficits in verbal behavior, personal care, socialization, play, motor skills, and preacademic skills. EIBI programs are most often implemented in the family home or a specialized center for 30–40 hours per week, involve one-on-one direct instruction and carefully planned small group or inclusion activities for 3 years or more, and enroll children as young as 2 years old (Butter, Wynn, & Mulick, 2003).

In 1987, Lovaas published the seminal report on intensive behavioral intervention for young children with autism. He compared the educational and cognitive outcomes for children with autism and mental retardation who received at least 2 years of 40 hour per week behavioral treatment to children who received 10 hours or less per week behavioral treatment and to children who did not receive any behavioral intervention. Forty seven per cent of the intensive behavioral intervention group achieved intellectual and educational functioning broadly within normal limits. In the

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control groups, only 2% of the children achieved similarly positive outcomes (Lovaas, 1987). In general, the children who obtained the best outcomes were reported to maintain their gains up to 5 years after treatment (McEachin, Smith, & Lovaas, 1993).

The original Lovaas (1987) findings have not been fully replicated by independent research groups. However, there are other reports that suggest intensive behavioral intervention can lead to remarkable outcomes for children with autism. Smith, Groen, and Wynn (2000) reported that a group of children who received intensive behavioral intervention made significant gains in cognitive and language skills over a similar group of children who participated in a less intensive parent-training model. However, the best outcomes were just half that of the best outcomes obtained in the earlier studies (Lovaas, 1987; McEachin et al., 1993). More recently, Howard et al. (2005) reported the results of a prospective study of autistic children that showed EIBI resulted in significantly greater cognitive gains and more rapid learning rates over an interval of slightly more than 1 year, as compared to children in either eclectic public school programs or non-intensive early intervention programs. Sallows and Graupner (2005) found positive group effects whether or not the home program was implemented by tutors who worked for and were supervised by the replication site or were recruited by the parents with only supervision and training by replication site staff. Cohen, Amerine-Dickens, and Smith (2006) found significant gains in IQ and adaptive behavior for children receiving EIBI compared to children receiving conventional special education services. There have been less rigorous reports of positive outcomes related to behavioral treatment of autism as well (see Perry, Cohen, & DeCarlo, 1995).

Some have questioned the relevance of behavior intervention outcome studies in light of information related to the general variability of cognitive, language, and adaptive outcomes over the developmental period. Eaves and Ho (2004) followed 49 preschoolers with social and language delays indicative of autism from age 2 to 4½ years, questioning the stability of diagnosis and the impact of interventions. Diagnostic assessments were completed at both ages and stability of the diagnosis was high across the 2 or more years; that is, of the children diagnosed with an autism spectrum disorder at 2 years, 79% continued to meet diagnostic criteria at 4½ years. Cognitive abilities were documented to change over time with some children demonstrating more than a 20 point gain in IQ while other children's IQ dropped by similar levels. The changes in cognitive functioning were not related to the type or intensity of intervention, but were related to the child's baseline functioning. Higher functioning children tended to do better over the long-term without necessarily being enrolled in an intensive behavior intervention program.

With the lack of well-controlled studies, conflicting information about the natural course and variability of functioning for children with autism, and the inconsistent ability to replicate the original Lovaas findings (Smith et al., 2000), there remain questions about the impact of behavioral intervention on PDD. The current study

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sought to contribute to this discussion by describing clinical outcomes of early intensive behavioral intervention for children with PDD. There are few case histories published of children who showed a marked increase in functioning and a decrease in autistic symptoms. Case studies are an important aspect of this literature because it has become financially and ethically challenging to implement a controlled study of EIBI. Parents and institutional review boards are becoming increasingly guarded, as they should be, about random assignment involving a treatment previously determined to be effective. A large scale, long-term controlled study of EIBI is prohibitively expensive given the personnel costs of providing one-on-one intervention for up to 3 years. Even when the obstacles to implementing a controlled study can be managed, controlled studies fail to capture the individual differences in how children respond to EIBI. Well-described case histories are one way to begin to characterize important individual differences related to EIBI outcomes.

METHOD

Participants

Participants were eight children previously diagnosed with Autistic Disorder or PDD-NOS *and* mental retardation. Recruitment was accomplished via internet advertisements on autism related listservs, from the authors' own independent case load at Columbus Children's Hospital, and through other local autism treatment providers. In total, 25 parents responded to solicitations which asked parents to respond if they believed their child had made remarkable progress *as a result* of EIBI and that *learning recovery had been achieved.*

Inclusion criteria were as follows: (1) Parents had to provide a documented DSM-IV (APA, 1994) diagnosis of Autistic Disorder or PDD-NOS by a doctoral level psychologist or medical doctor dated prior to beginning EIBI; (2) Parents had to provide a documented diagnosis of mental retardation (MR) supported by psychometrically reliable and valid measures of intellectual functioning and adaptive behavior by a doctoral level psychologist; (3) Parents had to provide evidence through data records and video tape of an appropriate EIBI program that followed a sequenced curriculum and implemented techniques of ABA for between 20 and 40 hours per week during active treatment; and, (4) Parents were required to indicate that they believed their child had made substantial progress and had a reasonable expectation that their child had achieved at least a 20 point gain in IQ score. Children were excluded from the study if any of these criteria were not met.

Of the 25 children screened for the study, 12 met inclusion criteria and 8 children were enrolled. Of the eight children enrolled, three were girls and five were boys. The

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four children who met inclusion criteria whose parents chose not to enroll were from other regions of the United States or from outside the United States and chose not to enroll because of travel expenses that the study could not reimburse. However, some families did travel great distances to participate. Three of the children enrolled in the study were previously treated by one or more of the study evaluators; however, the evaluation was conducted by study staff unfamiliar with the patient and family. There were eight children who did not meet inclusion criteria because of insufficient documentation related to pre-treatment functioning, while an additional five children were excluded because of inadequately designed or implemented EIBI programs or because it was clear from concurrent documentation that the child did not meet the expectation for at least a 20 point IQ gain.

Procedure

After eligibility for study enrollment was determined, children were scheduled for an evaluation. The evaluation typically occurred in one day, over a 6–8 hour period. The children completed standardized psychological, language, and academic tests. Though the clinical evaluators were aware of the purpose of the study, the psychometricians who administered the psychological testing with each child were blind to the purpose of the study. Test administration was video taped. After the evaluation was completed, parents were invited back to review results and to discuss treatment recommendations. However, treatment recommendations were not promised as part of the initial inducement to participate. Aside from the evaluation report, compensation for parking and lunch, and a Children's Hospital logo T-shirt and balloon, no other inducements were given to the families.

Evaluation Protocol

All eight children received a standard, conventional battery of psychological tests and measures of symptom severity and behavioral adjustment. On occasion, additional measures were given to answer unique clinical questions related to a particular child, and those individualized measures are not reported here. The list of tests and measures are reported in Table 1.

RESULTS

At the time of the study, the children ranged in age from 4 years, 2 months to 8 years, 8 months. On average, the children were enrolled in an EIBI program for 2.8 years and all children were *not* currently receiving EIBI services. Some children

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Table 1. Tests and measures.

General intelligence
Wechsler Intelligence Scale for Children: Third Edition (WISC-III; Wechsler, 1991)
Nonverbal intelligence
Leiter International Performance Scale: Revised (Leiter-R; Roid & Miller, 1997)
Adaptive behavior
Scales of Independent Behavior: Revised (SIB-R; Bruininks, Woodcock, Weatherman, & Hill-Itasca, 1996)
Language
5 years and older
Clinical Evaluation of Language Fundamentals (CELF; Semel, Wiig, & Secord, 1995)
Under 5 years
Peabody Picture Vocabulary Test: Third Edition (PPVT; Dunn & Dunn, 1997)
Expressive One Word Picture Vocabulary Test (EOW; Brownell, 2000)
Academic Achievement or Early Learning
First grade and above
Woodcock-Johnson Tests of Achievement: Third Edition (WJ-III; Mather & Woodcock, 2001)
Preschool and kindergarten
Bracken Basic Concept Scale: Revised (Bracken-R; Bracken, 1998)
Behavioral adjustment
Child Behavior Checklist (CBCL; Achenbach, 2001)
Autism symptom severity
Childhood Autism Rating Scale (CARS; Schopler, Reichler, & Renner, 1988)
Gilliam Autism Rating Scale (GARS; Gilliam, 1995)
Parent adjustment
Parenting Stress Index (PSI; Abidin, 1995)

were as many as 3 years away from their last EIBI service. EIBI services had been provided for 40 hours per week for three of the children, 20–30 hours per week for three children, and 10–20 hours per week for two children. Most of the children also attended community pre-school during the active phases of EIBI treatment and all of the children had had speech therapy services separately from EIBI. At the time of the post-treatment study evaluation, all the children had an Individualized Education Plan (IEP) and various special education supports within a regular educational environment.

IQ and Adaptive Behavior Outcomes

Pre-treatment intelligence scores were obtained through record review. All reported IQ scores were obtained by a doctoral level psychologist using standardized direct assessment measures, such as the Bayley Scales of Infant Development: Second Edition, the Mullen Scales of Early Learning, the Stanford-Binet Intelligence Scales: Fourth Edition, the Differential Abilities Scale, or the Wechsler Preschool and

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Table 2. Comparisons of standardized measurement of cognitive ability (IQ) before and after EIBI treatment.

	Pre-EIBI	*Post-EIBI*	*Change score*	*%-Change*
Case 1(m, 8 y 0 m, 3)[a]	43	70	27	62.79
Case 2 (m, 5 y 3 m, 2.5)	<50	80	>30	60
Case 3 (f, 6 y 1 m, 3)	<50	67	>17	34
Case 4 (f, 6 y 0 m, 2.5)	51	94	>43	84.31
Case 5 (f, 4 y 2 m, 2)	<50	82	>32	64
Case 6 (m, 7 y 7 m, 4)	<50	83	>33	66
Case 7 (m, 8 y 8 m, 2.5)	<50	83	>33	66
Case 8 (m, 6 y 10 m, 3)	52	114	62	119.23
Mean ± SD	$<49.5 \pm 2.73$	84.13 ± 14.67	34.64 ± 13.21	$69.54\% \pm 24.33$

[a]Gender, age at time of study, and number of years of EIBI treatment are in parentheses.

Primary Scale of Intelligence. All pre-treatment general IQ scores were found to be at or below a standard score (mean of 100, standard deviation of 15 or 16) of 52, more than two standard deviations below the mean for their population age groups. These scores represented moderate to possibly severe cognitive delays. Post-treatment intelligence standard scores using the Wechsler Intelligence Scale for Children: Third Edition ranged from 70 to 114. All children showed apparent increases in IQ scores. Using paired *t*-tests to analyze pre and post treatment standard scores indicated that the differences were significant ($t = 7.41$, $p < 0.001$). This was a very large effect size, $D = 3.51$. Pre- and post-treatment intelligence scores for each child are represented in Table 2.

The post-treatment IQ scores for Case 1 and Case 3 were at or below 70. These scores represented results of IQ testing when the subject initially presented to the study. In both cases, recommendations for additional treatment were made. A second and third post-treatment IQ score was obtained by the investigators 1 and 2 years after those recommendations were made. These scores are reported in Table 3. In addition, interim IQ scores were available for Case 3; the first score represents her IQ

Table 3. Additional IQ standard scores for case 1 and case 3.

	Pre-EIBI	*During EIBI*	*End of EIBI*	*At study*[a]	*1 year post-study*[b]	*2 year post-study*[b]
Case 1	43	NA	NA	70	100	115
Case 3	<50	62	80	67	71	88

'NA' indicates that these IQ scores were not available.
[a]This score represents the IQ score obtained at the time of the study evaluation.
[b]This score represents the IQ score obtained 1 year and 2 years later, after program recommendations were made and implemented.

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Table 4. comparisons of standardized measurement of adaptive behavior before and after EIBI treatment.

	Pre-EIBI	*Post-EIBI*	*Change score*	*%-Change*
Case 1(m, 8 y 0 m, 3)[a]	50	89	39	78
Case 2 (m, 5 y 3 m, 2.5)	55	118	63	114.55
Case 3 (f, 6 y 1 m, 3)	63	146	83	131.75
Case 4 (f, 6 y 0 m, 2.5)	66	105	39	59.09
Case 5 (f, 4 y 2 m, 2)	63	105	42	66.67
Case 6 (m, 7 y 7 m, 4)	67	92	25	37.31
Case 7 (m, 8 y 8 m, 2.5)	68	66	−2	−2.94
Case 8 (m, 6 y 10 m, 3)	60	115	55	91.67
Mean ± SD	61.50 ± 6.26	104.5 ± 23.59	43 ± 25.43	72.01% ± 42.79

[a]Gender, age at time of study, and number of years of EIBI treatment are in parentheses.

pre-treatment; the second score represents an IQ score obtained during the active phase of EIBI; the third score represents her IQ as measured immediately after EIBI services were ended; and, the fourth, fifth, and sixth scores represent the scores obtained by study evaluators 1 year apart, respectively.

Pre-treatment adaptive behavior levels were obtained by doctoral level psychologists using standardized, norm-referenced instruments such as the Vineland Adaptive Behavior Scales or the Scales of Independent Behavior: Revised. All children were reported to have adaptive behavior composite standard scores between 50 and 68 prior to EIBI treatment. These scores were within the mild to moderate range of developmental delay. Standard scores on the Scales of Independent Behavior: Revised at the time of the study ranged from 66 to 146. See Table 4 for pre- and post-treatment scores for each child. Using paired *t*-tests to analyze pre and post treatment adaptive behavior scores indicated that the differences were significant ($t = 4.78$, $p < 0.01$). This was a very large effect size, $D = 2.66$. Case 7 was the only child who did not make significant gains in adaptive behavior.

Additional Outcomes

Though pre-treatment non-verbal cognitive skills, language abilities, academic achievement, behavioral adjustment, severity of PDD symptoms, and parenting stress were not always characterized for each participant, these measures were assessed post-treatment to better characterize the sample.

Standard scores on the Leiter International Performance Scale: Revised ranged from 71 to 109, from the borderline range to the average range. In general, standard scores on receptive or expressive language tests represented significant delays across

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the sample compared to the relatively improved functioning obtained on the cognitive and adaptive behavior measures. Aside from Case 8, all the children had residual language deficits as indicated by one or both language scores in the impaired or borderline range. Receptive vocabulary standard scores ranged from 50 to 114, from the moderately impaired range to the high average range. Expressive vocabulary standard scores ranged from 68 to 118, from the mildly impaired range to the high average range. In contrast, academic skills were subsequently found to be at the low average range or higher for all participants, with standard scores ranging from 84 to 144. Table 5 shows the academic skills scores for each child.

Child Behavior Checklist Total Behavior Problem scores were within normal limits (T-scores below 70) except for Case 7, who obtained a T-score within the clinically significant range ($T = 72$). Regarding severity of autistic symptoms, only one child, Case 5, obtained a clinically significant score (30 or above) on the Childhood Autism Rating Scale. On the Gilliam Autism Rating Scale, only one child, Case 7, obtained a clinically significant standard score. On the PSI, three mothers were considered to be clinically stressed—Case 2, Case 6, and Case 7—with PSI Total Stress scores beyond the 97th percentile.

Table 5 also presents the individual scores for nonverbal IQ, language functioning, academic achievement, behavioral adjustment, autism symptoms, and parenting stress for all participants post-treatment.

An aggregated summary of current psychological functioning for the eight children is presented in Figure 1.

DISCUSSION

The children presented in this study achieved at least a 20-point gain in IQ over a 3–4 year period after early intensive behavioral intervention for autism. Strict inclusion criteria assured that the children met diagnostic criteria for autism or pervasive developmental disorder and MR prior to starting EIBI. Though any conclusions are provisional, and no causal inferences can be made, the clinical descriptions of children with autism or PDD achieving such measurable gains in cognitive abilities is still noteworthy. The developmental outcomes for the children in this study are similar to those of the best outcomes for children described in the Lovaas (1987) study. At the very least, the current data suggest that IQ gains are possible for children with autism and, perhaps, that EIBI helps to promote such gains.

As importantly, the data from the eight cases presented here contributes multidimensional information about the range of outcomes following EIBI for autism. Though all the children eventually showed at least a 20 point IQ gain, the mean IQ standard score post-treatment was 84, that is, prior to our study

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Table 5. Adjustment on non-verbal IQ, language, achievement, behavior, autism, and parenting stress measures after EIBI treatment.

	Non-verbal IQ[b]	*Language*		*Academic Achievement*[b]	*Behavioral Adjustment*[c]	*Autism CARS*[d]	*Symptoms GARS*[e]	*Parent Adjustment*[f]
		Receptive[b]	*Expressive*[b]					
Case 1(m, 8 y 0 m, 3)[a]	71	50	72	99	43	24	67	No
Case 2 (m, 5 y 3 m, 2.5)	89	78	68	95	46	27.5	63	Yes
Case 3 (f, 6 y 1 m, 3)	79	61	69	90	43	28.5	68	No
Case 4 (f, 6 y 0 m, 2.5)	96	94	75	112	50	19.5	70	No
Case 5 (f, 4 y 2 m, 2)	100	50	71	113	46	30	70	No
Case 6 (m, 7 y 7 m, 4)	102	82	72	105	49	19	72	Yes
Case 7 (m, 8 y 8 m, 2.5)	98	82	75	84	72	25	110	Yes
Case 8 (m, 6 y 10 m, 3)	109	114	118	144	59	17	45	No
Mean	93	76.38	77.5	105.25	51	23.81	70.63	
SD	12.63	22.10	16.55	18.65	9.92	4.83	18.08	

[a]Gender, age at time of study, and number of years of EIBI treatment are in parentheses.

[b]Leiter-R, language test, and achievement test scores are standard scores with a mean of 100 and standard deviation of 15; higher scores represent better functioning.

[c]CBCL scores are T-scores with a mean of 50 and standard deviation of 10; higher scores represent more significant behavior problems with scores above 70 being clinically significant.

[d]CARS scores of 30 and above are within the autistic range.

[e]GARS scores are standard scores with a mean of 100 and standard deviation of 15; higher scores represent greater severity of autistic symptoms with scores above 80 indicating clinical significance.

[f]PSI scores were interpreted with scores beyond the 97th percentile indicating clinically significant levels of parenting stress and are indicated by 'yes.'

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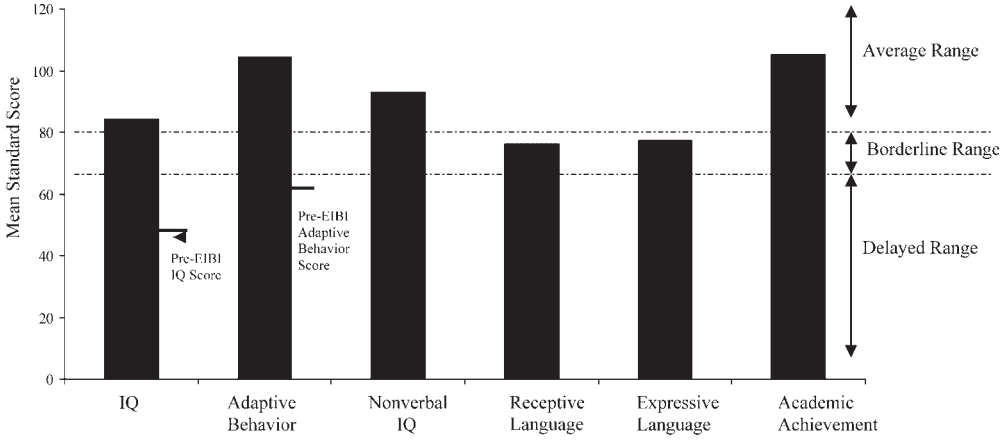

Figure 1. Aggregated psychological profile for eight children previously diagnosed with an autism or PDD-NOS and mental retardation following early intensive behavior intervention. The lines on the IQ and Adaptive Behavior bars mark the mean pre-EIBI score, while the top of the bar marks the scores at the time of study assessment.

recommendations for Cases 1 and 3. Six of the children had IQ scores below 85. This pattern suggests relatively fragile cognitive gains for most children.

In addition, there was further evidence of residual symptoms beyond the low average to borderline IQ scores for most of the children. All of the children, except one, had language standard scores within the borderline to mildly impaired range. Despite an overall gain in IQ, language skills were still below average for most children. And, though all the parents believed themselves to be 'finished' with intensive therapy, all but the one child who did not obtain lower language scores received recommendations from us that were designed to promote further language development. Given these language impairments, it is not surprising that about 40% of the parents reported on-going parenting stress within clinically significant levels.

The remainder of the psychological profile was more positive for most of the children. In general, adaptive behavior gains appeared to be strong. All of the children, except one, obtained adaptive behavior standard scores within the average range, above standard score 85. Similarly, all of the children, even those with lower cognitive, language, or adaptive scores, obtained average levels of academic achievement post-treatment, suggesting a relatively normal educational outcome, at least as far as expectation at early elementary school readiness or grade level was concerned. In general, behavior problems were sub-clinical as were most autistic symptoms.

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Case Analyses

Some case observations were noteworthy. Case 8 appears to have had the most beneficial outcome. His pre-treatment IQ was reported to be 52, and at post-treatment, his IQ standard score was 114; he obtained similar gains in adaptive behavior, going from a standard score of 60 prior to EIBI to a score of 115 post-treatment. Non-verbal IQ was within the average range as were his receptive and expressive language skills. This child's academic skills were within the superior range. There were no clinically significant reports of behavior problems, autistic symptoms, or parenting stress.

Case 7 appears to have had the least beneficial outcomes. Though he obtained a more than 30-point gain in IQ, his overall post-treatment IQ score was 83, low average to borderline. His functional independence remained mildly impaired in that there was no change in adaptive behavior standard scores. Language skills were within the borderline range and he obtained the lowest academic achievement standard score of all the children. By parent report on standardized questionnaires, autistic symptoms and behavior problems remained clinically significant and parenting stress was high. Several treatment factors may be related to his less than ideal outcomes. Case 7 was the oldest child in our sample at the start of treatment and, based upon parent report, his EIBI program was often interrupted by staffing and consultation problems. Further qualitative analyses are needed to better understand the factors related to the differential outcomes of this sample.

There was also evidence in this sample that follow-through interventions are likely important, even for children who have the best outcomes following EIBI. At initial study assessment, two children were found to have lower IQ's than expected given parent belief and report. Case 1 obtained a post-treatment IQ score of 70 during his initial study assessment. Following that assessment, a series of recommendations were made that were designed to promote further language development, verbal fluency, and verbal fluid reasoning skills. One year later, he was evaluated again and obtained a Full Scale IQ score of 100; additionally, an independent clinical evaluator reported a Full Scale IQ score of 115 two years after our recommendations were implemented. It appears that despite significant progress, some children still require specialized instruction following the most intensive phases of an EIBI program. This point is further illustrated by Case 3. Record reviews demonstrated that she obtained a full-scale IQ score of 80 immediately following the end of her EIBI program. At the time of the study assessment, she obtained a full-scale IQ score of 67. Similar recommendations were made to promote her verbal cognitive abilities. One year later, her full-scale IQ score was 71, still just barely within the borderline range. Two years after our initial study assessment and our recommendations for follow-through intervention, she was found to be within the normal range with a Full-Scale IQ score of 88.

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It is possible that conventional special education services were not sufficient to maintain all of the cognitive gains these children had made as a result of EIBI. Recommendations were made for these children, and to some respect all the children in the study, for closer consultation between the teacher and an EIBI consultant or behavior analyst. Additional academic recommendations for several children included after school tutoring 6–10 hours per week, direct instruction targeted at language enhancement, direct instruction targeted at reading comprehension and applied math, and an increase or return to speech therapy. All but one of the children, that is the child with the highest cognitive performance, were strongly advised to increase academic fluency, task persistence, and extend tolerance for longer periods of schoolwork. In some cases, the use of para-professionals was recommended as a way to increase participation and build generalization within the classroom. Social skills training recommendations included increasing the amount of structured social experiences supported by social scripts, social stories, and video modeling leading to increased participation in extracurricular and community activities.

Limitations

A significant limitation of case reports is that there is no control or comparison group. Without a control group, it is possible that the gains these children made, reflect the developmental trajectory these children would have followed regardless of having an EIBI program. However, given reports by others (Cohen, Amerine-Dickens, & Smith, 2006; Howard et al., 2005; Lovaas, 1987; Scheinkopf & Siegel, 1998; Smith, 1999; Smith, Groen, & Wynn, 2000; Sallows & Graupner, 2005), intensive behavioral intervention does have a strong influence in improving developmental functioning. Thus, it is more likely than not that EIBI did influence each child's outcome. Also, evidence from several of the children's profiles suggested that their cognitive skills remained responsive to more or even *less* intensive intervention. For instance, one child demonstrated a 30-point IQ gain in one year after supplementary treatment recommendations were made by the study evaluators. Another child demonstrated a decline in IQ at the time of the study compared to her first post-treatment IQ taken immediately after EIBI was completed. This pattern suggested that her IQ declined when regular educational methods were implemented without systematic planning of instruction. After 1 year of implementing recommendations made by the study evaluators, her IQ began to increase again, and her gains were clinically meaningful after two year.

Another limitation of the study is that the initial diagnoses could have been inaccurate. The diagnosis of MR in young children with autism is difficult because these children are very difficult to test. Standardized IQ tests require children to attend to an examiner's instructions and materials in order to make visual or verbal

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discriminations. Symptoms of autism likely interfere with testing conditions and artificially suppress scores. It is possible that the pre-treatment characterization of our subjects reflected an underestimate of what their abilities may have been at that time. Similarly, another criticism is related to the reliability of initial diagnosis. The inclusion criteria required a DSM-IV diagnosis based upon the observations and judgment of a doctoral level psychologist. Though this is a relatively rigorous standard, there were no objective pre-treatment measures of autism consistently used across all the children such as the Autism Diagnostic Interview: Revised (Lord, Rutter, & Le Couteur, 1994), Autism Diagnostic Observation Schedule (Lord et al., 1989), Childhood Autism Rating Scale (Schopler, Reichler, & Renner, 1988), or Gilliam Autism Rating Scale (Gilliam, 1995).

Also, this report represents an insufficient characterization of the quality of the children's EIBI programs. Because of the retrospective design, we were dependent upon parent reports and examination of treatment records and data sheets as quality indicators when documenting their EIBI programs. The children came from EIBI programs operated by different agencies and it is difficult to identify meaningful distinctions among the various service providers. Further qualitative analysis of the semi-structured clinical interview may provide additional information about program quality.

The study recruited only 8 participants despite our original target of 10 children, and the recruitment occurred beyond the originally planned time frame for the study. Though our recruiting targets were arbitrary, these children were harder to find than we expected given the proliferation of EIBI treatment programs and the increased reported incidence of autism. One possible consideration is that the rate of educational and intellectual recovery in autism as a result of EIBI is not as high in the community as found by Lovaas' experimental study (Lovaas, 1987). It is important to note that four additional children met inclusion criteria for the study, but were not included because of travel costs. Regardless, the overall low rate of response concerned us.

Also of concern was, of those families who responded to this study, there was a relatively low number who qualified for inclusion; less than 50%. This raises questions about the ways in which diagnoses are made, the trouble which families may have implementing and/or sustaining EIBI programs, the quality and fidelity of programs, and the ways in which progress is documented, areas which merit further research scrutiny.

Future Directions

The current study adds to the literature that meaningful learning recovery is possible for children with an autism or PDD. Questions remain about the possibility

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of significant numbers of children achieving complete recovery, and about the utility of this benchmark. The next step in this research program is to more comprehensively analyze the narrative data available from the semi-structured interview conducted with each parent. An analysis of the interviews is expected to yield information about the parent's experience with early diagnosis, consideration of alternative treatments, setting up and funding an EIBI program, the impact that autism and EIBI treatment had on the family, the use of different behavioral technologies, and their concerns about future developmental problems.

More broadly, it is important for additional comprehensive case reports of EIBI outcomes to be made available to the scientific and practitioner community. Prior to the current report, the best characterized case study was presented by Perry et al. (1995) and their report was lacking in comprehensiveness (Shapiro & Hertzig, 1995). With the lack of adequate controlled clinical trial data on EIBI, much can be learned from additional clinical case reports. One manner to do this would be to create a clearinghouse or national database of outcomes for children with Pervasive Developmental Disorders. The clearinghouse would serve as a collection center for outcomes of children who have participated in EIBI and other treatment programs. Outcomes across intervention models could be compared and described. Updated and more comprehensive cost-benefit models could be developed (see Jacobson, Mulick, & Green, 1998). Such information would be highly valuable to practitioners, parents, health insurance providers, and educational policy makers.

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