

Outcome of Early Intervention for Children with Autism

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Tristram Smith

Washington State University

ABSTRACT

Since 1980, 12 peer-reviewed outcome studies (nine on behavior analytic programs, one on Project TEACCH, and two on Colorado Health Sciences) have focused on early intervention for children with autism. Mean IQ gains of 7-28 points were reported in studies of behavior analytic programs, and 3-9 in studies on TEACCH and Colorado. Gains were also reported on other measures in some studies. Individual children varied greatly in treatment responsiveness. No fully randomized studies have been published, and studies with features such as large sample sizes and blind examiners have been rare. Further progress is likely to require more rigorous clinical trials, more comprehensive pretreatment and follow-up assessments, and greater attention to brain-behavior relationships.

Key words: autism, early intervention, treatment, outcome. [Clin Psychol Sci Prac 6:33-49, 1999]

Autistic disorder is among the most disabling forms of psychopathology (Klinger & Dawson, 1996). The disorder begins prior to 3 years of age and is a lifelong affliction for more than 90% of affected children. About half of all preschool-age children with autism are nonverbal. Many of the rest simply repeat what others say, rather than using language to communicate. Those who do have communicative speech are likely to use it only to express wants or to deliver monologues on topics that preoccupy them, as opposed to more purely social purposes such as conversing with others. Most have limited attachment to caregivers. They may wander away from caregiver when in public, display little interest in pleasing them, make scant effort to involve caregivers in their activities, evade eye contact, and resist displays of physical affection. In a group of peers, children with autism are likely to go off by themselves. Also, instead of playing imaginatively with toys, they often engage in repetitive behaviors such as arranging objects into neat rows, flapping their hands in front of their eyes, and gazing at spinning objects for extended periods of time. When these behaviors are interrupted, or when the children do not get their way, many have intense tantrums that may include aggression toward others or self-injurious behaviors such as banging their heads against hard objects. About 75% perform in the range of mental retardation on standardized intelligence tests. Much research shows that the disorder is biological in origin. However, the precise etiology or etiologies remain unknown, and effective medical interventions have yet to be identified, though some medications may assist in controlling disruptive behaviors (Smith, 1993).

After many years of finding that children with autism made only small or temporary improvements in treatment (DeMyer, Hingtgen, & Jackson, 1981), investigators in the mid 1980s began to report substantial success with some early intervention programs (Dawson & Osterling, 1997; Green, 1996a; Simeonsson, Olley, & Rosenthal, 1987). These successes have included average gains of approximately 20 IQ points on standardized tests of intelligence (e.g., Anderson, Avery, DiPietro, Edwards, & Christian, 1987; Harris, Handleman, Gordon, Kristoff, & Fuentes, 1991; Lovaas, 1987), similar gains on other standardized tests (e.g., Anderson et al., 1987; Hoyson, Jamieson, & Strain, 1984; McEachin, Smith, & Lovaas, 1993), and placement in less restrictive classrooms than are typically offered to children with autism (e.g., Fenske, Zalenski, Krantz, & McClannahan, 1985; Lovaas, 1987).

Such findings offer new hope for children with autism, their families, and their caregivers. In addition, they are potentially relevant to children with other developmental delays, who may display problems

similar to those of children with autism and hence may benefit from similar interventions (Lovaas & Smith, 1988). Society as a whole may also benefit, because increasing children's independence sharply reduces the cost of providing services (Lovaas, 1987) and enables the children to become more productive citizens.

From a theoretical standpoint, successful early intervention may alter perceptions of children's potential to change with treatment. For instance, many investigators have maintained that the intellectual functioning of children with autism, as measured by IQ, is essentially unchangeable (Runer, 1983) and that the limit for any group of individuals, whether developmentally disabled or not, is approximately $10 + 2$ IQ points (Scarr & Amen, 1987; Weinberg, 1989). Clearly, the reports of IQ gains averaging 20 points in children with autism far exceed these limits. Also called into question is the widely held belief that children's rate of language acquisition is affected only slightly by instruction from adults (Pinker, 1994). In early intervention, some previously nonverbal children have reportedly achieved average or even superior verbal skills relative to typically developing children (Lovaas & Smith, 1988; McEachin et al., 1993).

Nevertheless, existing findings need to be interpreted cautiously. Historically, most reports of major gains made by children with autism have withered under scrutiny (Green, 1996b; Smith, 1996). The same has been true of reports on children with other developmental delays (Spitz, 1986) and other behavior problems (Dawes, 1994). This recurrent problem has had tragic consequences for many children and families, who have placed their faith in interventions that have turned out to be ineffective (Jacobson, Mulick, & Schwartz, 1995).

The foregoing considerations highlight the importance of scrutinizing exactly what studies have reported and how scientifically sound they have been. Several reviewers have summarized the studies (Dawson & Osterling, 1997; Green, 1996a; Matson, Benavidez, Compton, Paclawsky, & Baglio, 1996; Rogers, 1996; Simeonsson et al., 1987; Smith, 1993), but none have critiqued them in detail. The present article aims to fill this gap.

SEARCH METHOD

The author conducted a computer search of articles published since 1980 and abstracted on Eric, IC (U.S. Department of Education), Medline (U.S. National Library of Medicine), or Psyc Lit (American Psychological Association) as of December 1996. The search used two lists key terms and examined all possible combinations containing one term from List A and one from List B:

List A: autism, autistic disorder, infantile autism, early infantile autism, childhood autism, autistic child(ren), autistic individual(s), pervasive developmental disorder(s)

List B: treatment, therapy, intervention, school, education, class(room), outcome, milieu, program evaluation, early intervention, post treatment, follow-up, behavior analysis, behavior modification, structured teaching, development(al), developmentally appropriate practice

To determine whether this search omitted relevant studies, the author inspected citations in reviews by Dawson and Osterling (1997), Green (1996a), Harris and Handleman (1994), Rogers (1996), and Smith (1993).

All studies that met the following criteria were included: (a) the children averaged 5 years old or younger at treatment onset; (b) the children received direct services as part of the study (e.g., classroom placement or one-to-one instruction); (c), the services were comprehensive, aimed at addressing multiple problems displayed by children language, cognition, socialization, self-help, motor skills, etc., rather than only one of these); (d) in either the initial report or subsequent publications, the authors of the study indicated that it provided data on treatment outcome; and (e) the study appeared in a peer-reviewed journal. Altogether, the search identified nine outcome studies on behavior analytic treatment programs (Green, 1996a), one on Project TEACCH (Lord & Schopler, 1994), and two on the Colorado Health Sciences Program (Bogers & DiLalla, 1991).

Behavior Analytic Early Intervention Programs

Behavior analytic treatment (Lovaas & Smith, 1989) emphasizes the use of principles derived from research on operant conditioning. Therapists often simplify children's environments to maximize successes and minimize failures. For example, they may work toward a target behavior by initially accepting a rough approximation of it and then reinforcing closer and closer approximations (shaping). Or they might break the behavior down into smaller units, teach each unit individually, and then link the units together (chaining). Another common simplification is the use of a discrete trial format, characterized by (a) one-to-one interaction with a therapist, (b) short and clear instructions from the therapist, (c) carefully planned procedures for prompting children learn to follow the instructions and for fading such prompts, and (d) immediate reinforcement for each correct response made by children. Behavior analytic treatment also emphasizes the use of functional analyses. In such analyses, therapists monitor the immediate antecedents and consequences of behaviors so that they can determine how they might alter these antecedents and consequences to improve children's skills: For example, to evaluate whether children have mastered a behavior, therapists may assess whether the children are performing the behavior in response to verbal instructions or to extraneous cues such as inadvertent gestures made by the therapist (e.g., looking in the direction of the correct response). To maintain children's motivation, therapists may assess how much interest children display for various different reinforcers and select those that seem especially attractive. To reduce disruptive behaviors, therapists may identify antecedents that appear to trigger the behaviors and consequences that appear to reward the behaviors, so that these antecedents and consequences can be altered.

In the 1960s, many behavior analytic investigators attempted to identify a central problem whose remediation would yield widespread improvements. However, these efforts proved unsuccessful. For example, investigators found that an increase in language skills did not by itself lead to an increase in peer interactions, or vice versa. Hence, they concluded that they needed to treat as many behavior problems as possible, rather than trying to identify a central problem. Investigators also found that gains made in one setting with one therapist often did not generalize across settings and people. Therefore, it became evident that treatment should occur in multiple settings (home, school, neighborhood) and involve multiple people (parents, peers, teachers, etc.; see Lovaas & Smith, 1989; Newsom & Rincover, 1989).

Behavior analytic investigators have employed an "inductive" (Lovaas & Smith, 1989) or "constructive" (Kazdin, 1992) research strategy, developing interventions piece by piece in a cumulative manner. Matson et al. (1996) reported that investigators have published more than 550 peer-reviewed studies, many of which have incorporated rigorous single-case experimental designs, on the use of (behavior analytic treatment approaches for children with autism. Large numbers of investigators exist on managing aberrant behaviors and on enhancing language, social interaction, self-care, and academic skills (Matson et al., 1996). For many treatment goals, several alternative, empirically supported therapy approaches exist (Dunlap & Robbins, 1991). For instance, investigators have shown that therapists can use discrete trial approaches to establish communicative, vocal language in most nonverbal children with autism (Howlin, 1981; Lovaas, 1977). When unsuccessful in establishing vocal language, therapists often can teach children to use visual communication systems, such as sign language or picture boards (visual skills being a strength for many children with autism: Cam 1979). Alternatively, therapists may proceed in the reverse direction, starting with a visual communication system and, when children master it, switching to vocal language (Bondy & Frost, 1994). Another viable option is to instruct children to use visual and vocal communication simultaneously (e.g., signing and vocally labeling an object at the same time; Carr & Dores, 1981). Thus, behavior analytic investigators have identified many specific, empirically supported treatment methods (Newsom & Rincover, 1989; Schreibman, 1988; Smith, 1993). Parents and teachers those children have participated in behavior analytic treatment generally rate the treatment positively (Runco & Schreibman, 1987; Smith & Lovaas, 1998). Thus, strong evidence exists for the efficacy of behavior analytic approaches in ameliorating a wide range of problems displayed by children with autism.

Nevertheless, only a handful of studies have focused on long-term, overall outcomes achieved by children in behavior analytic programs. Table I contains summaries of the interventions provided by each of the

seven behavior analytic programs where investigators have published outcome data on preschoolers with autism. Table 2 presents an overview of the nine outcome studies that exist on these programs.

As shown in Table 1, children at the UCLA Young Autism Project (Lovaas, 1987; McEachin et al., 1993) received the most intensive intervention (40 hr/week of one-to-one treatment in their homes and communities for approximately 3 years). Table 2 indicates that these children also achieved remarkably favorable outcomes. Intensively treated children averaged 22-31 points higher on tests of intellectual and adaptive functioning than did children in two control groups. They also achieved substantially less restrictive school placements and, according to a parent questionnaire, lower levels of psychopathology. McEachin et al. (1993) identified several strengths in this study: (a) control groups that did not differ from the intensively treated group at intake on all but 1 of 20 intake measures, (b) use of a treatment manual (Lovaas et al. 1981) and associated videotapes (Lovaas & Leaf, 1981) to standardize intervention and facilitate replications, (c) diagnoses and assessments conducted by examiners independent of the study to minimize bias. (d) use of multiple intake and follow-up measures to assess functioning across different domains (intelligence, adaptive behavior, etc.), and (e) long-term follow-ups conducted many years after termination of treatment to assess maintenance of gains over time. However, critics have argued that the study contained major weaknesses (Gresham & MacMillan, 1997; Schopler, Short, & Mesibov, 1989): The investigators assigned children to intensive or minimal treatment on the basis of therapist availability, rather than a more arbitrary (and scientifically sounder) procedure such as using a random numbers table. At intake, different children received different intelligence tests, as selected by their examiner. This practice may have lowered the reliability of the intake IQ data. Also, in the view of some investigators (e.g., Schopler et al., 1989), Lovaas's sample functioned at a higher level at intake than is typical of children with autism. Moreover, according to Mundy (1993) and others, the follow-up assessments may have failed to detect residual problems in areas such as social skills and regulation of emotions. Lovaas and colleagues have concurred with the concerns about subject assignment and intake assessment. However, they have disputed the latter two criticisms by presenting data indicating that their sample was comparable to other samples and that the follow-up assessments had the power to detect residual problems (Lovaas, Smith, & McEachin, 1989; Smith & Lovaas, 1997; Smith, McEachin, & Lovaas, 1993).

Table 1. Treatment programs with peer-reviewed outcome data on preschoolers with autism

BEHAVIOR ANALYTIC PROGRAMS:

DOUGLAS: 25 hr/wk of intervention in either a self-contained class or a class consisting of approximately equal numbers of children with autism and typically developing children. "Programs emphasize language and social development individually paced . . . Incidental teaching techniques are extensively employed with discretionary instruction as needed . . . Support for home programming is provided as well" (Handleman et al, 1991, p 138) Classes were run by certified special education teachers

LEAP: 15 hr/wk of intervention in class with typically developing children The program integrated behavior analytic approaches with "developmentally appropriate practice" (Bredekamp, 1987). Extensive efforts were devoted to having children with autism learn from interactions with typically developing peers via modeling, direct instruction from peers, and arrangement of classroom environment to promote interplay among children. Certified special education teachers and aides also provided some one-to-one instruction as well as guidance during group activities (Strain & Cordisco. 1994)

MAY: 25 hr/wk of intervention based on the UCLA model (described below) from (a) therapists having bachelor's or master's degrees in psychology/and 30 hr of in-service training regarding the UCLA model and (b) parents.

MURDOCH: Average of 18 hr/wk of intervention based on the UCLA model (described below) from community volunteers who typically worked 2.5 hr/wk for 4 months and were overseen by three clinic supervisors and the investigators.

PCDI: 27.5 hr/wk in multiple settings with other children with autism PCDI" does not espouse any specific behavior modification procedures, but systematically employs an applied behavior analytic approach to intervention" (Fenske et al., 1985, pp. 53-54). Intervention usually began with instructing children to respond to simple requests, then proceeded to imitation, matching, adherence to a picture schedule, and language development. Intervention was provided mostly by individuals with bachelor's or master's degrees in psychology/or education (McClannahan & Krantz. 1994).

UCLA: 40 hr/wk of intervention based on manual by Lovaas et al. (1981). First year focused on one-to-one, in-home, discrete trial intervention aimed at teaching children to respond to basic requests, imitate, begin to play with toys, and interact with family. Second year focused on teaching language and introducing children to typically developing peers. Third year focused on teaching emotions, preacademic skills, observational learning, and adjustment to school settings. Therapists were undergraduates who worked for a minimum of 6 months under supervision from the investigators and personnel with master's degrees in psychology and 2 or more years experience with the intervention. Parents also provided 5-10 hr/wk of intervention

UCSF: Average of 19 hr/wk of intervention based on the UCLA model (described above) for children from their families, who received consultation from UCLA, or from individuals in their communities and hired therapists from local colleges

OTHER PROGRAMS:

TEACCH: 25 hr/wk of intervention designed to accommodate strengths and weaknesses of children with autism. For example, because visual skills tend to be more advanced than verbal skills, instructions may be presented in pictures rather than spoken words, and tasks may have visual prompts (grooves to indicate where to place certain items, pictures of each step in a task, etc.). Because classroom noise and intrusions from peers may be distracting or aversive, they often work at individual workstations rather than with peers, though some activities occur in small groups Because transitions from one activity to the next may

be difficult, children may have a highly structured schedule displayed at their workstations. Primary service providers are licensed special education teachers who have completed a workshop on TEACCH.

COLORADO: 22.5 hr/wk of intervention based on (a) Jean Piaget's theory of cognitive development, which focuses on how children explore their environments in order to construct schemas about how the world works and how to reason about it; (b) Margaret Mahler's psychoanalytic theory of child development, which centers on how children establish a sense of identity and an understanding of others through interactions with caregivers; and (c) the INREAL functional communication program, which aims to enhance communication in the context of naturally occurring activities.

Table 2. Outcome studies on early intervention for children with autism

Program	Participants	Design	Outcome Measure(s)	Results
Behavior analytic programs				
Douglass Harris et al. (1990)	Children with autism ($N = 10$) Intake means: chronological age (CA) = 57 months, IQ = 66, Language Quotient (LQ) = 70	Children assigned to self-contained ($n = 5$) or integrated ($n = 5$) classroom, based on assessment of which setting was more appropriate Follow-up conducted at $M = 11$ months postintake	Preschool Language scale (PLS; Zimmerman, Steiner, & Pond, 1979)	$M \Delta PLS = +7$
Handleman et al. (1991)	Children with autism (N unspecified) Intake means: CA = 49 months, BDI Developmental Quotient (DQ) = 48 ($n = 6$), LAP DQ = 72 ($n = 7$)	Same as above (n unspecified) Follow-up conducted at $M = 9$ months postintake	Battelle Developmental Inventory (BDI; Newborg, Stock, Wnek, Guidubaldi, & Svinicki, 1984), Learning Accomplishment Profile (LAP; LeMay, Griffin, & Sanford, 1977)	$M[6] \Delta BDI = +12$ $M[7] \Delta LAP = +20$
Harris et al. (1991)	Children with autism (N unspecified) Intake means: CA = 49 months, IQ = 68 ($n = 9$), LQ = 67 ($n = 7$)	Same as above (n unspecified) Follow-up conducted at $M = 11$ months postintake	Stanford-Binet IV (S-B; Thorndike, Hagen, & Sattler, 1986), PLS	$M[9] \Delta S-B = +19$ $M[8] \Delta PLS = +8$
LEAP (Hoyson et al., 1984)	6 "autistic-like" children Intake means: CA = 40 months, DQ = 71	Intake evaluation and follow-up evaluation conducted at $M = 9$ months postintake	LAP	$M[6] \Delta LAP = +17$
May (Anderson et al., 1987)	14 children with autism Intake means: CA = 43 months, IQ = 53, Social Quotient (SQ) = 45, LQ = 48	(a) Multiple baseline across behaviors; (b) standardized testing at intake, 1 yr, and 2 yr	Behavior observations, Bayley Scales of Infant Development (Bayley, 1969) or S-B, Vineland Adaptive Behavior scales (Sparrow, Balla, & Cicchetti, 1984), language test battery	1 yr: $M[12] \Delta = +7-11$ 2 yr: $M[6] \Delta = +22-24$
Murdoch (Bimbrauer & Leach, 1993)	9 children with autism Intake means: CA = 39 months, IQ = 51, SQ = 46, LQ = 28, nonverbal IQ = untestable	(a) Time series of behavior observations, (b) standardized testing at intake and 2 yr later, (c) comparison with children not qualifying for study	Behavior observations, Bayley/S-B, Vineland, Reynell Developmental Language scales (Reynell, 1987), Leiter International Performance scales (Leiter, 1959)	(a) Behavior observations indicative of improvement with intervention (2) 2 yr follow-up means: $\Delta Bayley/S-B = +7$ $\Delta Vineland = -5$ $\Delta Reynell = +6$ $\Delta Leiter = +29$
PCDI (Fenske et al., 1985)	18 children with high rates of autistic behaviors: 9 under 5 years CA ($M = 49$ months) and 9 over 5 years CA ($M = 101$ months)	Comparison of younger and older group	Graduation from PCDI and entry into public school	Graduation rate: Younger group = 6 of 9 Older group = 1 of 9
UCLA (Lovaas, 1987; McEachin et al., 1993)	59 children with autism Intake means: CA = 34 months, IQ = 60	Assignment to groups based on therapist availability: (a) experimental group received intensive (40 hr/wk) intervention ($n = 19$) for 2 or more yr, (b) control group 1 ($n = 19$) for 2 or more yr; (c) control group 2 ($n = 21$) consisted of children never referred to the investigators. Follow-ups at CA = 7 yr and M CA = 12 yr	School placement (regular class, class for aphasic children, class for developmentally delayed children); Bayley/S-B/Wechsler Intelligence Scales for Children-Revised (WISC-R; Wechsler, 1974); age 12 follow-up only; Vineland, Personality Inventory for Children (Wirt, Lachar, Klinedinst, & Seat, 1977), clinical interview	(1) Age 7 follow-up: M IQ: Exp Grp = 83, Ctrl Grp 1 = 52, Ctrl Grp 2 = 57 School placement: Exp Grp, 8 of 19 in regular class, Ctrl Grp 1, 0 of 19, Ctrl Grp 2, 1 of 21 (2) Age 12 follow-up: M IQ: Exp Grp = 85, Ctrl Grp 1 = 54 M Vineland: Exp Grp = 75, Ctrl Grp 1 = 53 Exp Grp lower elevations on PIC; 8 of 19 score in normal range on all measures

Table 2. Continued

Program	Participants	Design	Outcome Measure(s)	Results
UCSF (Sheinkopf & Siegel, 1998)	20 children with autism, 2 with PDD Intake means: CA = 35 months, IQ = 65	(a) Treatment group ($n = 11$) consisting of children whose families sought UCLA treatment; (b) comparison group ($n = 11$) consisting of children who were matched on CA and mental age and whose families did not seek UCLA treatment Follow-up conducted at M 19 months postintake	Merrill-Palmer Scale of Mental Tests (Stutsman, 1948)	M Merrill-Palmer: Tx Grp = 90 Comp Grp = 62
Other Programs TEACCH (Lord & Schopler, 1989)	72 3-year-olds (M CA = 38 months, M IQ = 57) and 70 4-year-olds (M CA = 55 months, M IQ = 58)	3-year-olds followed up at M CA = 7 yr, 8 months; 4-year-olds at M CA = 9 yr, 1 month	Merrill-Palmer, Leiter, or WISC-R Performance IQ	M Δ IQ: 3-year-olds = +7 4-year-olds = +3
Colorado Rogers et al., (1986)	13 children diagnosed with autism by the CARS (8 of 13 confirmed by clinicians) (M CA = 48 months, M IQ = 72), 10 other children (M CA = 51 months, IQ = 81)	Follow-up averaging 5 months later	Early Intervention Developmental Profile (EIDP; Schafer & Moersch, 1981); observations of play	M Δ IQ = +4-6; improved play
Rogers & DiLalla (1991)	49 children diagnosed with autism or PDD based on CARS (M CA = 46 months, M IQ = 73)	Follow-up averaging 6.4 months later, comparison with non-PDD children	EIDP	Δ IQ = +4-9

Note: Unless otherwise noted, all standardized test scores are presented as ratio IQs.

*Deviation score.

Reports of partial replications of the UCLA project have come from three sites: the May Center (Anderson et al. 1987), Murdoch University (Birnbrauer & Leach, 1993), and UCSF (Sheinkopf & Siegel, 1998). Children at all sites received less intensive services than children at UCLA (an average of 18-25 hr/week, instead of 40). Also, service providers received less frequent supervision from senior staff and, at one site (Murdoch), appeared to have substantially less experience, typically leaving after 13 weeks of providing 2.5 hr of treatment per week (a total of 32.5 hr). Despite these differences, children who received treatment based on the UCLA model in the UCSF study (Sheinkopf & Siegel, 1998) scored an average of 28 IQ points higher than children in a comparison group that did not receive such treatment at follow-up (90 vs. 62). The investigators reported that children who averaged 25 hr/week of treatment appeared to fare as well as children who averaged 35 hr and suggested that treatment need not be as intensive as at the UCLA project. However, the small number of children at each level of intensity (five) prevented a sensitive test of this issue. The results from May and Murdoch were more mixed than those from UCSF. At May, a 2-year follow-up revealed that the children averaged increases of 20-22 points over intake on standardized tests. However, only 6 of 14 children in the study participated in this follow-up. Therefore, the results may not be representative of the gains made by all children treated at the site. At Murdoch, the investigators reported that their group of nine children made significant gains, but when the results are expressed as IQ (as in Table 2), it appears that the group showed little improvement. Data on individual children indicated that four of the nine children gained on standardized tests but the remaining five declined. The one exception to this pattern was that all children improved on the measure of substantial skills. These relatively unfavorable results may be attributable to the staffing problems noted above or to the fact that the sample had the lowest retake of any in the present review. In any case, it is evident that, at least under some circumstances, behavior analytic early intervention programs may fail to yield clearly positive results.

While the foregoing programs were home based (especially during the first year of treatment), the remaining programs in Table 1 were school based, with 15-27.5 hr/ week of service. Children in all school-based programs (Douglass, LEAP, and PCDI) tended to enter group settings at an earlier stage of treatment than did children in home-based programs, though one-to-one therapy was also provided. As shown in Table 1, the LEAP program placed a particular emphasis on entry into groups containing typically developing peers. As with some studies on home-based programs, the three studies on the Douglass Center (Handleman, Harris, Celiberti, Lilliheht, & Tomchek, 1991; Harris et al., 1991; Harris, Handleman, Kristoff, Bass, & Gordon, 1990) yielded mixed results. Children gained an average of 19-20 IQ points on two measures of cognitive development but only 12 points on a third such measure and 7-8 points on a measure of language development. This discrepancy suggests either that the intervention had more impact on some areas of functioning than others or that some measures of cognitive functioning detect change more readily than do measures of language functioning. The studies on PCDI (Fenske et al., 1985) and LEAP (Hoyson et al., 1984) indicated that, with treatment, children achieved less restrictive school placement and more advanced cognitive development, respectively. However, each study contained only one outcome measure, precluding comparisons across measures.

In sum, though all investigators reported substantial improvements, the nature of improvements varied substantially across studies. Some investigators found gains in all areas that they assessed (Anderson et al., 1987; Lovaas, 1987). Others obtained major gains in some areas but much smaller improvements in others (e.g., Harris et al., 1991). Finally, Birnbrauer and Leach (1993) reported little improvement in the group as a whole but some individuals did quite well. The most favorable outcomes occurred in the study that provided the most intensive services: Lovaas's (1987) study on the UCLA Young Autism project. Otherwise, no clear correlations are evident among treatment intensity, treatment model, and outcome.

Lovaas (1987) noted that the children in his study seemed to divide into two groups: (a) a best outcome group of nine children who made major gains on standardized tests and appeared at follow-up to be functioning like typically developing children in many respects, and (b) a group of 10 children whose standardized test scores changed little and who remained substantially delayed. LEAP (Hoyson et al., 1984), May (Anderson et al., 1987), and Murdoch (Birnbrauer & Leach, 1993) also reported substantial individual differences in treatment responsivity. All but LEAP (Hoyson et al., 1984) indicated that some children failed to make significant gains. Across these studies, children with the highest standardized test

scores at intake tended to improve the most, but exceptions were numerous. The remaining studies in Table 2 did not present data on individual differences.

As a whole, the studies contained numerous methodological weaknesses. No study contained a procedure for randomly assigning children to groups. Only three studies included some procedures for introducing experimental controls (Anderson et al., 1987; Lovaas, 1987; Sheinkopf & Siegel, 1998). These procedures reduced some validity threats but were not optimal. For example, assigning children to groups based on therapist availability (as done by Lovaas, 1987) or based on whether families sought behavior analytic treatment (also done by Lovaas, 1987, as well as by Sheinkopf & Siegel, 1998) enabled comparisons between groups that received alternative interventions. However, potential biases remained, such as possible differences between families that succeeded in obtaining the experimental treatment for their children and those that did not. Anderson et al. (1987) employed a multiple baseline design in which children received treatment after waiting for various lengths of time. Their design revealed that children's functioning remained stable prior to treatment, regardless of the length of the pretreatment phase, and improved with treatment onset. However, the design did not permit a test of whether such benefits endured over time. Because treatments commonly have short-term but not long-term benefits (e.g., Lovaas, Koegel, Simmons, & Long, 1973), this is a significant limitation.

Though independent clinicians diagnosed children with autism in all studies, only those in the studies by Harris et al. (1990) and Handleman et al. (1991) relied on a standardized diagnostic instrument, The childhood autism Rating scale (CARS: Schopler, Reichler, DeVellis, & Daly, 1988). Further, two children in Harris et al. (1990) and an unspecified number in Handleman et al. (1991) did not meet criteria for autism on this instrument, even though it classifies more children as having autism than do most other measures (e.g., Van Bourgondien, Marcus, & Schopler, 1992). Thus, in these studies and perhaps also in the other studies reviewed here, some children may not have met generally accepted criteria for a diagnosis of autism.

Only in studies on the UCLA program have independent clinicians performed pretreatment and follow-up assessments besides diagnostic evaluations (Anderson et al., 1987; Birnbrauer & Leach, 1993; Lovaas, 1987; McEachin et al., 1993; Sheinkopf & Siegel, 1998). In two of these studies, independent clinicians conducted most but not all assessments (Anderson et al., 1987; McEachin et al., 1993). Other problems across studies included (a) the existence of detailed descriptions or treatment manuals for only some of the intervention procedures (all studies on school-based programs), (b) the absence of data on whether children's gains endured after the termination of treatment (all studies except McEachin et al., 1993), (c) the use of a smaller sample size than investigators such as Kraemer (1981) consider minimally necessary for a sound outcome study (all studies except Anderson et al., 1987; Lovaas, 1987; Sheinkopf & Siegel, 1998), (d) the reliance on a single outcome measure (Fenske et al., 1985; Hoyson et al., 1984; Sheinkopf & Siegel, 1998), and (e) the employment of inexperienced therapists (Anderson et al., 1987; Birnbrauer & Leach, 1993).

In general, the UCLA study (Lovaas, 1987) appears to have had the fewest of the above-mentioned weaknesses, followed by the other studies on home-based programs, though replications of these studies are certainly needed. All five studies on school-based programs contained many significant methodological shortcomings.

Other Early Intervention Approaches

Apart from behavior analytic treatment, many other psycho-educational interventions are available for children with autism. Little research exists on any of these interventions (Smith, 1993), but outcomes of early intervention have been reported for Project TEACCH and Colorado Health Sciences. Project TEACCH, originally a statewide program in North Carolina and now an intervention model implemented throughout the United States and Europe, has been the most influential special education program for children with autism. The program shares with behavior analytic programs an emphasis on (a) treating multiple problems rather than attempting to identify a central deficit and (b) having treatment occur in multiple settings with the involvement of many people. Also, the program sometimes incorporates behavior

analytic approaches for controlling disruptive behaviors and enhancing self-help skills. However, in their treatment manual, Schopler, Reichler, and Lansing (1980) recommend against using behavior analytic approaches for other skills such as language. According to Schopler et al. (1980), interventions based on clinical experience are more likely than behavior analytic approaches to generalize from intervention settings to everyday life. Also, the interventions favored by TEACCH are designed to accommodate the existing strengths and weaknesses of children with autism (Lord & Schopler, 1994, p. 99), rather than remediating the weaknesses, as in many behavior analytic programs. For example, children may receive individual rather than group instruction (though group instruction also occurs), visual rather than verbal cues, and routines rather than unstructured times (see Table 1). Most children in TEACCH have been placed in classrooms that contain other children who have developmental disabilities. However, recent publications have given increased emphasis on exposing children with autism to typically developing children (e.g., Lord & Schopler, 1994).

In support of the TEACCH model, Schopler, Brehm, Kinsbourne, and Reichler (1971) found that two of four children with autism learned more with structured than unstructured interventions, Rutter and Bartak (1973) confirmed this finding in a much larger investigation. However, the latter result may have stemmed from preexisting differences among groups rather than the effects of structured interventions: The mean initial IQ of the children in the structured intervention was 66, compared to 48 and 52 in the two comparison groups (Smith, 1993). A number of other studies have indicated that TEACCH may be effective. Unfortunately, all such studies have been uncontrolled (Aoyami, 1995; Keel, Mesibov, & Woods, 1997; Marcus, Lansing, Andrews, & Schopler, 1978; Ono, 1994; Panerai, Ferrante, & Caputo, 1997; Short, 1984), incompletely described (Schopler, Mesibov, & Baker, 1982), or, as acknowledged by the investigators difficult to interpret because of potentially major confounds (Bristol, Gallagher, & Holtz, 1993); Ozonoff & Cathcart, 1998). Hence, there is a need for additional controlled studies.

Though focusing primarily on psychometric properties of cognitive tests, Lord and Schopler (1988, 1989) also obtained data on early intervention in TEACCH (Lord & Schopler, 1994). On average, children gained 3-7 IQ points from ages 3-4 years to ages 7-9 years (Table 2). Lord and Schopler (1988) noted that these data may overestimate children's progress because the follow-up assessment, which emphasized visuospatial skills, often yield higher scores in children with autism than those given at the initial assessment. The investigators also reported that the 44 lowest functioning children (nonverbal children with IQ < 50) tended to make the largest IQ gains, averaging 15-24 points. By contrast, the remaining 98 children tended to show little change in IQ. Language gains were also reported but not analyzed to determine whether the gains were attributable to treatment or other factors such as maturation. The investigators concluded that the cognitive functioning of most children in TEACCH remained stable over time, though a subgroup made gains. Venter, Lord, and Schopler (1992) reached a similar conclusion in a study of children who averaged 6 years of age and were classified as high functioning at intake.

The program at Colorado Health Sciences emphasizes helping children with autism learn through play and is based on Piagetian and object relations theories (see Table 1), though it also incorporates behavior analytic techniques for behavior management. Rogers and colleagues have found that school personnel give high ratings to staff training in this model (Rogers, Lewis, & Reis, 1987). In two outcome studies (Rogers & DiLalla, 1991; Rogers, Herbison, Lewis, Pantone, & Reis, 1986), mean IQ rose 3-9 points (see Table 2). The investigators characterized these increases as statistically and clinically significant but did not present data needed to verify these analyses (e.g., standard deviations at follow-up). Thus, their conclusion is open to question. Another potential difficulty is that the interval between intake and follow-up (averaging 5-6 months) may have been too brief to reveal the full effects of this intervention.

Several methodological features of the foregoing studies are noteworthy: The study on TEACCH contained a longer term follow-up than all other studies in the present review except Lovaas (1987; McEachin et al., 1993). In addition, the studies on TEACCH and Colorado Health Sciences were based on much larger sample sizes than those on behavior analytic treatments. Further, Colorado Health Sciences was the only site other than Douglass in the present review to use a standardized diagnostic instrument. Moreover, treatment manuals exist for TEACCH and for the language programs, though not for the other programs, used at Colorado. Still, all studies centered on largely untested treatment approaches, and all contained nonexperimental designs, nonblind examiners, and only one primary outcome measure. Also, given the

emphasis in TEACCH on accommodating rather than overcoming deficits associated with autism, this outcome measure (IQ change) may have been less suitable than alternatives (e.g., assessing children's quality of life) for ascertaining whether the goals of TEACCH had been met.

DISCUSSION

A number of investigators have reported that children with autism make major gains with early intervention. The present review included nine such reports on behavior analytic treatment, one on Project TEACCH, and two on Colorado Health Sciences. Unfortunately, close inspection of these reports reveals that the results have been less favorable than reviewers have claimed (Dawson & Osterling, 1997; Rogers, 1996). Some studies have yielded highly favorable results on every outcome measure given (notably McEachin et al., 1993). However, others have produced favorable results on some measures but not all (e.g., Harris et al., 1990, 1991). Four others, including one on behavior analytic treatment (Birnbrauer & Leach, 1993) and all three studies on other interventions (Lord & Schopler, 1989; Rogers & DiLalla, 1991; Rogers et al., 1986), have found little change. Two of these four studies (Birnbrauer & Leach, 1993; Lord & Schopler, 1988) indicated that a subgroup of participants fared well, but each study also contained a larger subgroup whose standardized test scores tended to decline or remain stable.

Substantial individual differences in treatment responsivity have emerged. In the six investigations that examined such differences (Anderson et al., 1987; Birnbrauer & Leach, 1993; Hoyson et al., 1984; Lord & Schopler, 1988; Lovaas, 1987), all indicated that some children made great progress while others did not. In studies on behavior analytic treatment, relatively high-functioning children at pretreatment were apt to make the largest gains at follow-up, but in the study on TEACCH, the lowest functioning children reportedly benefited most. Whether these trends are reliable remains to be determined.

Of great concern is that most studies have lacked even the most basic features of scientifically sound studies, such as an experimental or quasi-experimental design, reliable assessments, and replicable descriptions of the treatments that children received. Most studies also suffer from other substantial weaknesses such as small sample sizes and employment of therapists who apparently had minimal training and experience. Further, 11 of 12 did not provide data on children's progress following the termination of treatment (the exception being McEachin et al., 1993). This is a crucial omission because, even if children acquire skills in treatment, they may not continue doing so after the treatment ends, when they may no longer be receiving specialized services. Consequently, children may fail to derive long-term benefits—an outcome that would defeat the purpose of early intervention. In the present review, it was often necessary to reanalyze data to determine precisely what was found because investigators at each of the nine sites with outcome data have presented test scores in a different way, some have selectively reported positive but not negative aspects of their data in subsequent presentations of their work (e.g., Handleman & Harris, 1994; Lord & Schopler, 1994), and many have combined peer-reviewed and non-peer-reviewed data (e.g., McClannahan & Krantz, 1994; Strain & Cordisco, 1994) or presented only the latter (e.g., Koegel, 1995; McGee, Daly, & Jacobs, 1994).

The foregoing problems hinder drawing firm conclusions from existing early intervention studies. However, it appears that, as indicated in Table 2, the UCLA study (Lovaas, 1987; McEachin et al., 1993) had both the most favorable results and the strongest methodology. Though this study has generated much controversy, commentators have agreed on two points (Baer, 1993; Foxx, 1993; Kazdin, 1993; Mesibov, 1993; Mundy, 1993): The study makes a strong case that children with autism in the study made major, long-lasting improvements as a result of the treatment they underwent. However, the study needs to be replicated by independent investigators using improved methodologies. Two of three studies that have conducted partial replications of this study (employing the same treatment manual but providing fewer hours of treatment and altering some treatment procedures) have also reported favorable results (Anderson et al., 1987; Sheinkopf & Siegel, 1998). However, the third reported mixed results, with one subgroup making gains and another showing declines on standardized tests (Birnbrauer & Leach, 1993). The extent to which more exact replications would obtain results comparable to those of Lovaas (1987) remains an open question of considerable importance. At this time, though, the long-term effects of the UCLA model developed by Lovaas and colleagues have been the most rigorously documented of any treatment model for children with autism. Other behavior analytic treatment programs almost certainly yield short-term

benefits (Matson et al., 1996), and preliminary evidence indicates that they may also produce long-term benefits, while interventions based on different theoretical orientations, such as TEACCH and Colorado Health Sciences, appear essentially invalidated at this time.

FUTURE DIRECTIONS

The hundreds of single-case experiments on treatment for children with autism signify a remarkable effort to overcome this severe disorder, and some outcome studies indicate that a major breakthrough may have occurred. Nevertheless, these studies require replications with improved research methodologies and, even if interpreted in the most favorable possible light, reveal substantial shortcomings in the interventions under investigation. Therefore, much research remains to be done.

Outcome studies with random assignment to groups will be critical. However, a number of impediments to such studies exist: costs due to the length and intensity of treatment (potentially more than offset by reductions in children's subsequent need for services, but still difficult to fund: Smith & Lovaas, 1997), reluctance on the part of investigators to undertake studies that will require many years to complete (Kazdin, 1993), and ethical concerns about (and parental opposition to) random assignment involving children as impaired as those with autism (McIlvane, 1996). Even so, two groups of investigators have reported that randomized studies are underway (Smith et al., 1993; Strain & Cordisco, 1994). Other randomized studies that compare one viable treatment with another (e.g., two different, well-established behavior analytic programs) may also be feasible. At sites where random assignment cannot be carried out, investigators still can and should use designs that provide some control, such as those employed by Anderson et al. (1987), Lovaas (1987), and Sheinkopf and Siegel (1998), rather than settling for nonexperimental designs. One opportunity to use such designs may arise when investigators receive requests to disseminate their intervention models on a large scale such as a statewide basis, as has happened on several occasions (Lord & Schopler, 1994; McGee et al., 1994). If, as is probable, the model is disseminated in stages instead of all at once a wait-list control group may be feasible. Another useful strategy would be to evaluate individual components of treatment packages. Thus, investigators might conduct single-case experiments combining the effects of differing levels of treatment intensity. (e.g., 20 vs. 40 hr/ week), naturalistic versus discrete trial approaches (e.g., Koegel, O'Dell, & Koegel, 1987), behavior analytic versus alternative interventions, and so on.

In addition to incorporating control conditions, studies will require improved procedures for assessment. Standardized instruments for diagnosing autism based on generally accepted criteria (DiLavore, Lord, & Rutter, 1995; Lord, Rutter, & LeCouteur, 1994) have recently been developed and should replace unstandardized diagnoses from clinicians. More comprehensive evaluations of outcome are also important. Studies have focused primarily on measures of intellectual functioning. The use of such measures as part of an assessment battery is appropriate because most children with autism have delays in intellectual functioning and because intelligence tests are known to have good psychometric properties with this population (Rutter, 1983). For example, even at age 23 years, children's scores tend to be quite stable and have Pearson correlations of about .70 with scores obtained 4-5 years later (Freeman, Ritvo, Needleman, & Yokota, 1985; Lord & Schopler, 1989). However, independent examiners should administer the tests (as occurred in all studies on home-based programs but not in any other study in the present review). Additionally, because such tests are more difficult to administer to children with autism than to typically developing children, further precautions may be advisable, such as assessing interexaminer reliability, internal consistency of children's responses (e.g., Volkmar, Hoder, & Cohen, 1985), and correlations with other measures (e.g., Freeman, Ritvo, Bice, Yokota, & Ritvo, 1991). Moreover, outcome measures should assess children's functioning in areas besides intelligence, as children with autism display difficulties across many domains (language, social development, self-care, play and leisure skills, rituals, and aggression or tantrums). Standardized surveys that address many of these problems are currently under development for adults and adolescents with autism (Rutter et al., 1988), but not for younger children. Hence, investigators have disagreed on how to proceed. One approach, advocated by Smith et al. (1993) and illustrated by McEachin et al. (1993), emphasizes the use of instruments such as personality inventories that may detect a wide range of difficulties and enable comparison with norms for typically developing children. Another viewpoint, expressed by Mundy (1993), is that investigators should select measures specific to the problems that are considered most chronic in children with autism such as

pragmatics (Tager-Flusberg, 1997), recognition of mental states in others (Baron-Cohen, 1995), executive functioning (Ozonoff, 1995), and regulation of emotions (Szatmari, Bartolucci, Brenner, Bond, & Rich, 1989). Perhaps some combination of these strategies will emerge as best. Additional elements of a comprehensive outcome assessment would include standardized measures of Quality of Life for children and parents (e.g., Schalock, 1996) and anonymous ratings of client satisfaction.

Besides randomized clinical trials, investigations of the mechanisms by which treatments exert their effects will be of interest. Investigators have identified numerous, specific behavior analytic techniques for giving cues, prompts, and reinforcers that appear central to the success of an intervention (see Smith, 1993). However, they have also suggested that nonspecific factors such as creating expectations of success and maintaining strong relationships with children and families are likely to be important (e.g., Dawson & Osterling, 1997; Lovaas & Smith, 1988; Schopler, 1987), and the role of these factors is not yet well understood. Nonspecific factors are usually thought to work by instilling hope in demoralized or distressed clients (Frank & Frank, 1993). Certainly, children with autism and those who interact with them (especially parents) may become demoralized by the children's problems with communicating and interacting. Hence, while it is doubtful that, in themselves, nonspecific efforts to instill hope would overcome a severe neurological disorder such as autism, there is reason to believe that such efforts are a significant component of treatment. Hence, elucidating the role of such factors would likely be worthwhile. Another relatively unexplored area is the impact of contextual factors such as socioeconomic status and family makeup. Some have expressed concern that intensive early interventions may be too arduous for all but well-off, two-parent families (e.g., Schopler et al., 1989). At this point, there is little evidence one way or the other. Thus, further investigation is warranted.

Related to the concern about intensity of treatment, one thrust of current research has been to investigate ways to make interventions more efficient and easier on participants (children, families, and therapists). Because of the severity of autism, limits almost certainly exist on how far one can reduce the need for intensive and specialized services, but research in this area is clearly of interest. Particular attention has been given to "naturalistic" (as opposed to discrete trial) interventions (e.g., Koegel & Koegel, 1995). Of the outcome studies in the present review, the investigation by Hoyson et al. (1984) on LEAP may be most supportive of the use of such interventions (see Tables 1 and 2), and more comprehensive evaluations of this program are underway (Strain & Cordisco, 1994). In addition to outcome studies, investigators have conducted single-case experiments indicating that skills acquired through naturalistic instruction may transfer more readily across settings and evoke more favorable responses from participants than do discrete trial approaches (Koegel et al., 1987; Miranda-Linne & Melin, 1992; Schreibman, Kaneko & Koegel, 1991). However, two key issues remain to be addressed. First, the quality of treatment in both naturalistic and discrete trial conditions needs to be monitored to ensure an evenhanded comparison. Measures of treatment quality currently exist for discrete real approaches (Koegel, Russo, & Rincover, 1977), though not for naturalistic approaches used with children with autism. Second, to demonstrate that naturalistic approaches can replace and not just supplement discrete trials approaches, studies should focus on skills previously considered so difficult for children with autism that a simplified, discrete trial format was necessary (e.g., establishing words, observational learning, or toy play in children who previously lacked skills in these areas altogether). Examples of such studies exist for other clinical populations (McLean & Cripe, 1997).

Studies to date have made clear that some children with autism benefit much more than others from treatment. Single-case experiments on treatment continue at a rapid pace (Matson et al., 1996) and may be expected to enhance treatment effectiveness. For example, despite much important research (e.g., Strain & Kohler, 1988), interventions for developing social skills are not as developed as those for language (Hurley-Geffner, 1995), and ongoing research may rectify this situation. Benefits may also accrue from greater integration between treatment research and research aimed at specifying the deficits most characteristic of autism. As an illustration, drawing on studies showing defects in the perspective-taking ability of children with autism, Ozonoff and Miller (1995) developed a social skills training program for this population and presented evidence that the program was successful. Another way to improve outcomes may be to diagnose and begin treatment at an earlier age. Until recently autism was considered difficult to diagnose prior to 3 years of age, but studies have identified promising methods for identifying children as young as 18 months old (Baron-Cohen et al., 1996) and perhaps even 12 months (Osterling & Dawson,

1994). An additional strategy for improving outcomes would be to study how to predict individual children's response to treatment. Such a prediction would enable service providers to direct efforts toward those most likely to benefit while investigators worked to enhance interventions for those with less favorable prognoses. Apart from the usual difficulties associated with making any forecasts about young children, an obstacle to predicting outcomes in preschool-age children with autism is that, on the measures usually given to these children, they show smaller individual differences than do older children (Lord, 1995). Investigators have proposed three promising but little-tested solutions to this problem. First, instead of relying exclusively on pretreatment assessments, one could monitor children's rate of progress early in treatment and use this information to project their eventual outcome—in essence, sampling children's response to treatment (Lovaas & Smith, 1988). Second, one could use assessment instruments that may be more predictive of later outcome than those ordinarily used, such as information processing tests of cognitive functioning like the Fagan Test (Fagan & Vasen, 1997). Third, one could examine developmental markers of readiness to acquire skills. For example, social referencing behavior, such as a child following the direction of another person's pointing gesture or checking whether the person is looking at the same thing the child sees, may facilitate language acquisition. Hence, the presence of such behavior may bode well for language instruction (Mundy, Sigman, & Kasari, 1990).

Because autism is biological in origin, learning-based interventions, which are now the mainstay of treatment, will sooner or later need to be integrated with findings from biomedical research. Considering the heterogeneity of clinical presentation in autism and the long-running failure to identify a simple etiology for the disorder, investigators such as Bailey, Phillips and Rutter (1996) doubt there will be any "magic bullet." They suspect instead that solutions will come from taking specific deficits in behavioral functioning to particular neurological mechanism(s). Treatment researchers could play a key role in this process. For example, children who not only display deficits relative to typically developing children but also persist in doing so despite receiving the best available treatment may constitute a more homogeneous sample for studying associated biomedical problems than would a general group of children with autism. Thus, children who remain nonverbal after treatment, who display persistent weaknesses in executive functioning that impair their school performance despite adequate cognitive and academic skills, who cannot be induced to give up routines for more appropriate leisure activities, or who do not learn to recognize the perspective of others in social situations may be especially informative about the neural basis for each of these deficits. Also, the neural functioning of children who largely overcome such deficits with treatment may differ from untreated children, as has been observed in other clinical populations (Schwartz, Stoessel, Baxter, Martin, & Phelps, 1996). The exploration of such differences would thus be a promising avenue of research.

It is encouraging that debates over how much and what kind of early intervention children with autism should receive have largely replaced debates over whether such intervention merits any particular emphasis at all. Carefully designed outcome studies, further research on enhancing treatment, and exploratory investigations of brain-behavior relationships hold promise for moving these debates forward.

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